FIG.1

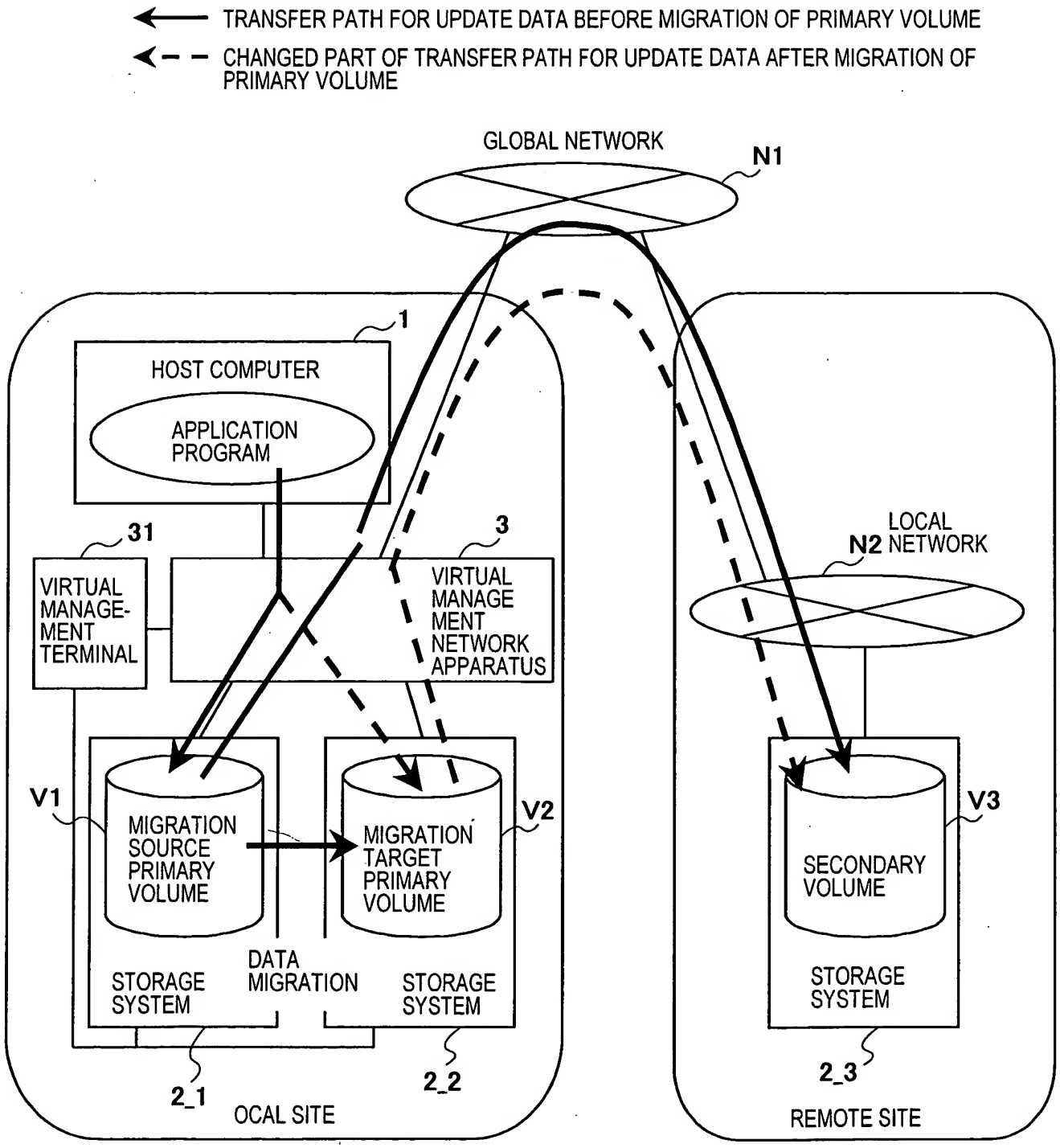

TRANSFER PATH FOR UPDATE DATA BEFORE MIGRATION OF PRIMARY VOLUME
CHANGED PART OF TRANSFER PATH FOR UPDATE DATA AFTER MIGRATION OF PRIMARY VOLUME
GLOBAL NETWORK
N1
1
HOST COMPUTER
APPLICATION PROGRAM
31
VIRTUAL MANAGE-MENT TERMINAL
3
VIRTUAL MANAGE MENT NETWORK APPARATUS
LOCAL N2 NETWORK
V1
MIGRATION SOURCE PRIMARY VOLUME
V2
MIGRATION TARGET PRIMARY VOLUME
V3
SECONDARY VOLUME
DATA MIGRATION
STORAGE SYSTEM
STORAGE SYSTEM
STORAGE SYSTEM
2_1
2_2
2_3
OCAL SITE
REMOTE SITE

FIG.2A

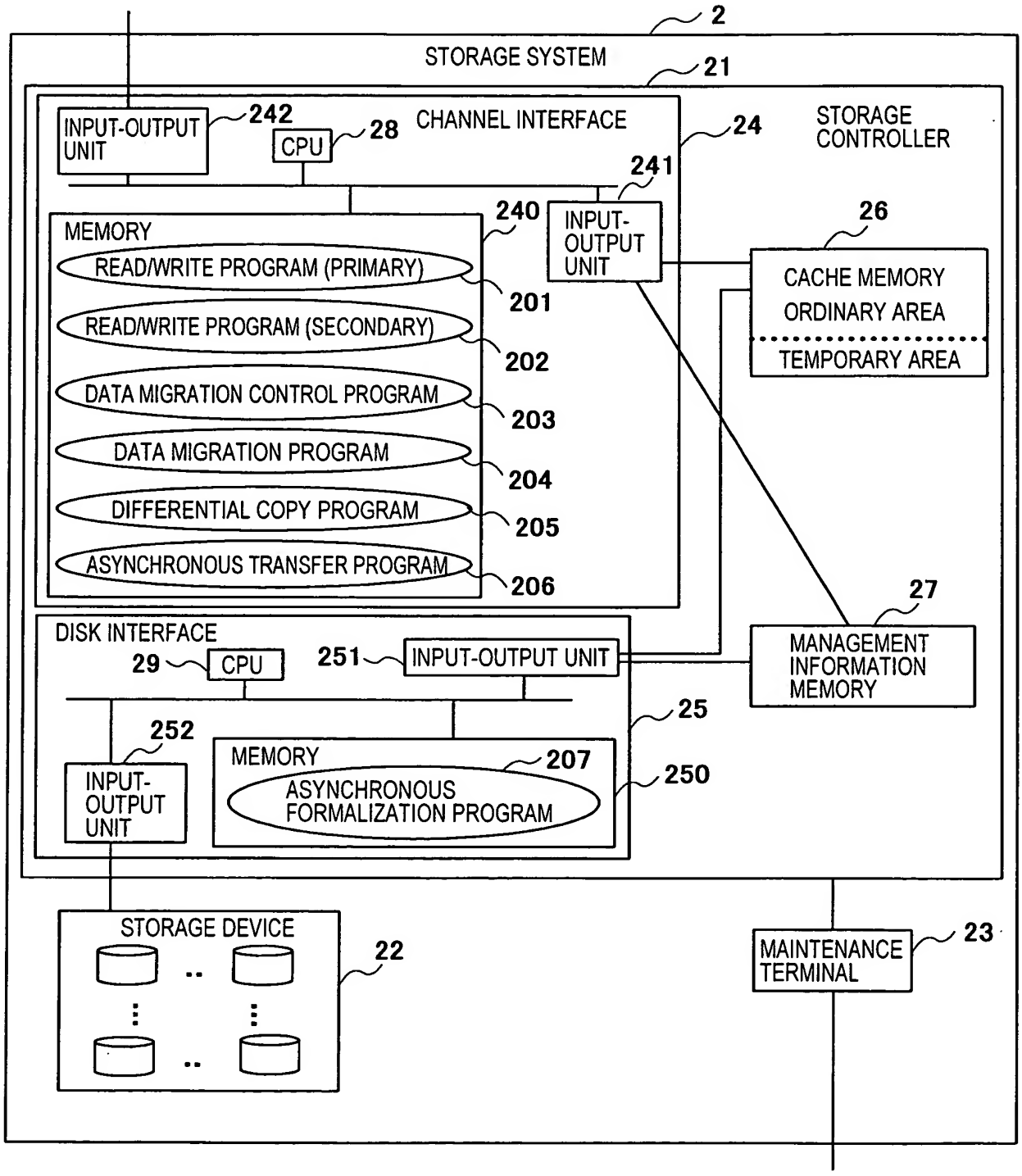

2
STORAGE SYSTEM
21
INPUT-OUTPUT UNIT
242
CPU
28
CHANNEL INTERFACE
24
STORAGE CONTROLLER
241
240
INPUT-OUTPUT UNIT
26
MEMORY
READ/WRITE PROGRAM (PRIMARY)
201
READ/WRITE PROGRAM (SECONDARY)
202
DATA MIGRATION CONTROL PROGRAM
203
DATA MIGRATION PROGRAM
204
DIFFERENTIAL COPY PROGRAM
205
ASYNCHRONOUS TRANSFER PROGRAM
206
CACHE MEMORY
ORDINARY AREA
TEMPORARY AREA
27
DISK INTERFACE
29
CPU
251
INPUT-OUTPUT UNIT
MANAGEMENT INFORMATION MEMORY
25
252
INPUT-OUTPUT UNIT
MEMORY
207
ASYNCHRONOUS FORMALIZATION PROGRAM
250
STORAGE DEVICE
22
MAINTENANCE TERMINAL
23

FIG.2B

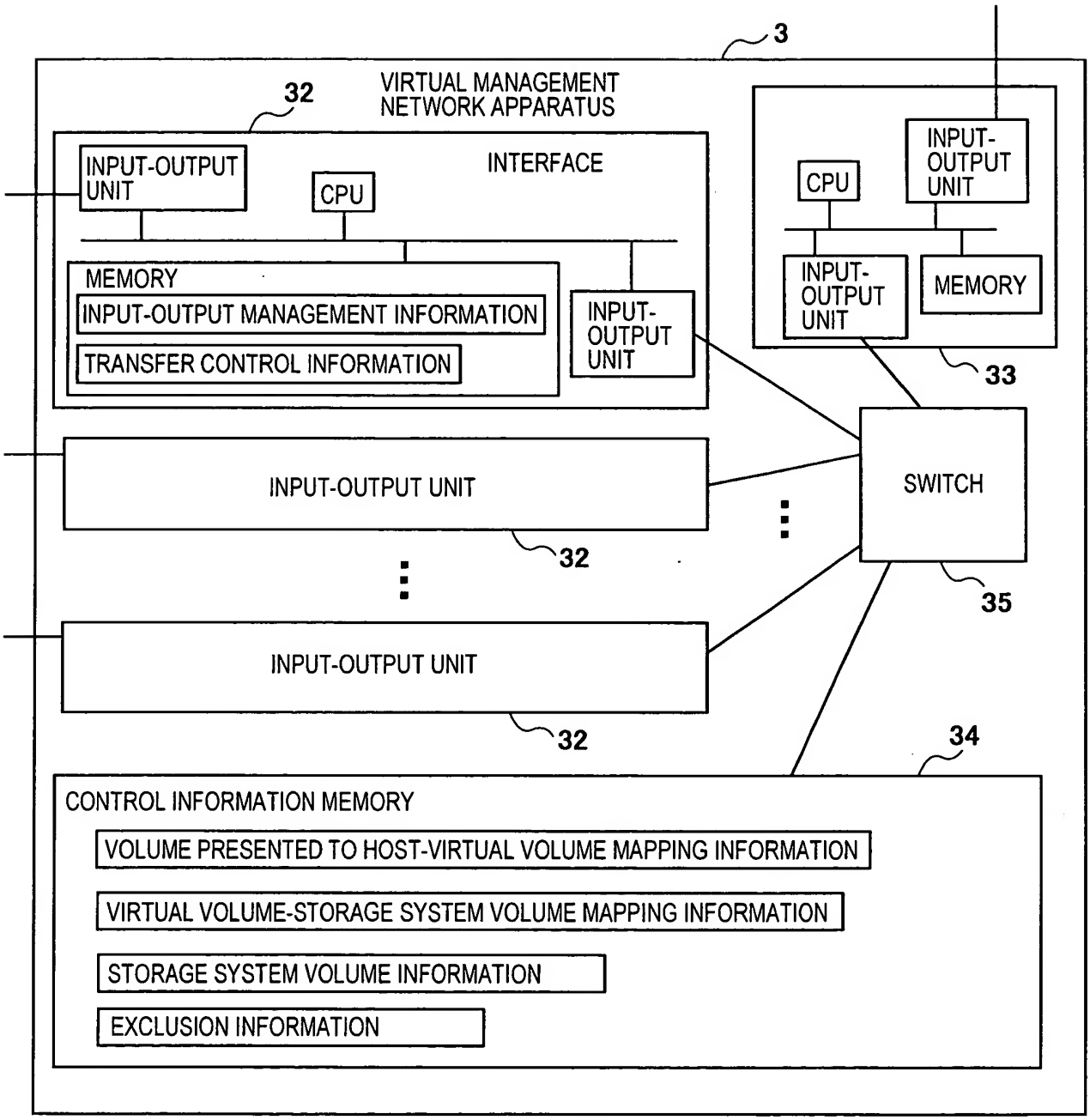

3
VIRTUAL MANAGEMENT NETWORK APPARATUS
32
INPUT-OUTPUT UNIT
CPU
INTERFACE
MEMORY
INPUT-OUTPUT MANAGEMENT INFORMATION
TRANSFER CONTROL INFORMATION
INPUT-OUTPUT UNIT
CPU
INPUT-OUTPUT UNIT
INPUT-OUTPUT UNIT
MEMORY
33
SWITCH
INPUT-OUTPUT UNIT
32
35
INPUT-OUTPUT UNIT
32
34
CONTROL INFORMATION MEMORY
VOLUME PRESENTED TO HOST-VIRTUAL VOLUME MAPPING INFORMATION
VIRTUAL VOLUME-STORAGE SYSTEM VOLUME MAPPING INFORMATION
STORAGE SYSTEM VOLUME INFORMATION
EXCLUSION INFORMATION

FIG.3A

SEQUENCE NUMBER	TRANSFER/FORMALIZATION OBJECT INFORMATION		CACHE MEMORY MANAGEMENT INFORMATION ADDRESS
	FORWARD ADDRESS	BACKWARD ADDRESS	
1	0101 ···	1100 ···	1001 ···
3	0111 ···	0110 ···	0100 ···
⋮	⋮	⋮	⋮
17	1111 ···	1011 ···	1101 ···

FIG.3B

SEQUENCE NUMBER COUNTER	99
TRANSFER OBJECT MANAGEMENT INFORMATION	0100 ···
	1011 ···
FORMALIZATION OBJECT MANAGEMENT INFORMATION	0101 ···
	1011 ···

FIG.3C

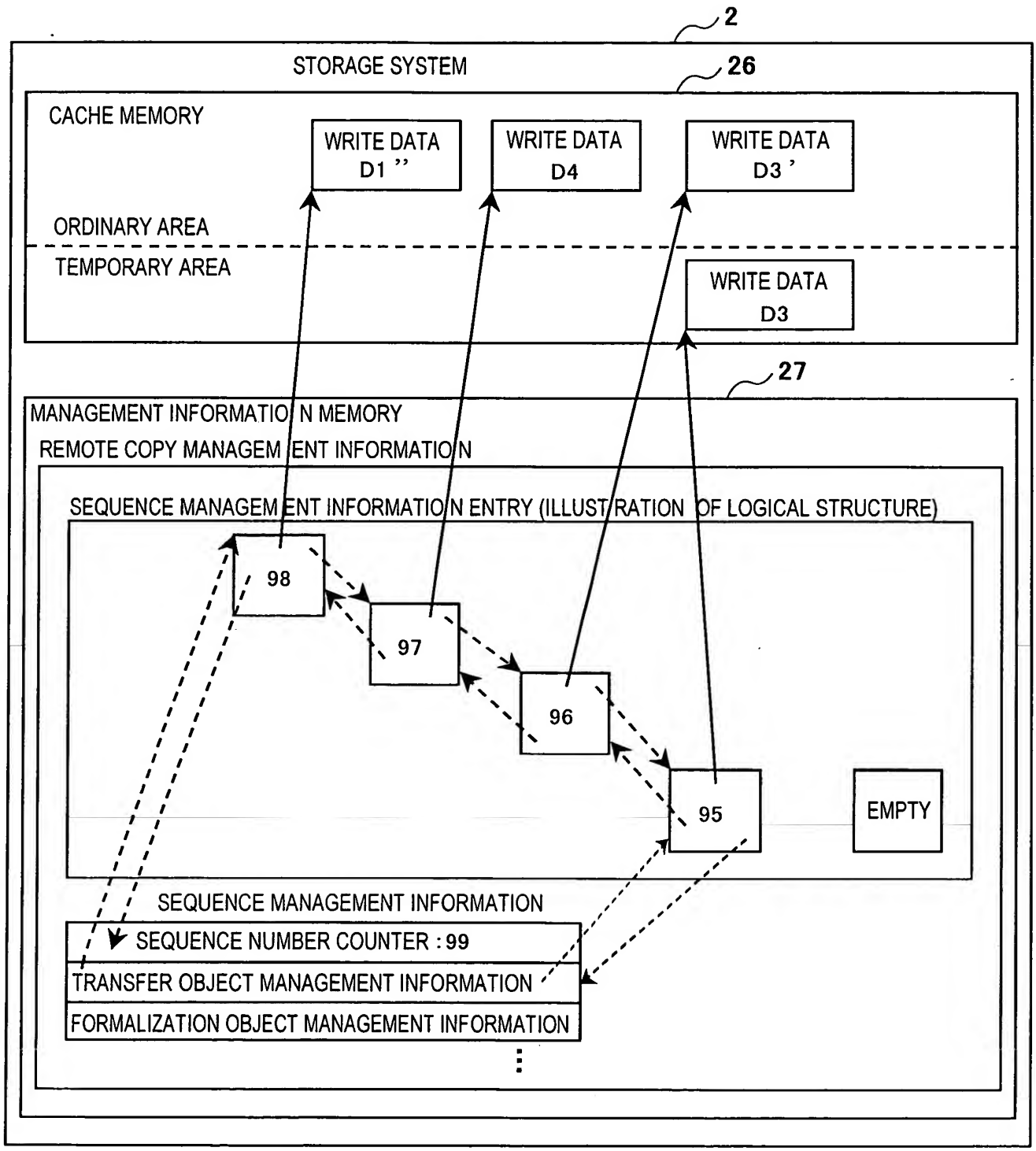

2
STORAGE SYSTEM
26
CACHE MEMORY
WRITE DATA D1 ''
WRITE DATA D4
WRITE DATA D3 '
ORDINARY AREA
TEMPORARY AREA
WRITE DATA D3
27
MANAGEMENT INFORMATIO N MEMORY
REMOTE COPY MANAGEM ENT INFORMATIO N
SEQUENCE MANAGEM ENT INFORMATIO N ENTRY (ILLUST RATION OF LOGICAL STRUCTURE)
98
97
96
95
EMPTY
SEQUENCE MANAGEMENT INFORMATION
SEQUENCE NUMBER COUNTER : 99
TRANSFER OBJECT MANAGEMENT INFORMATION
FORMALIZATION OBJECT MANAGEMENT INFORMATION

FIG.3D

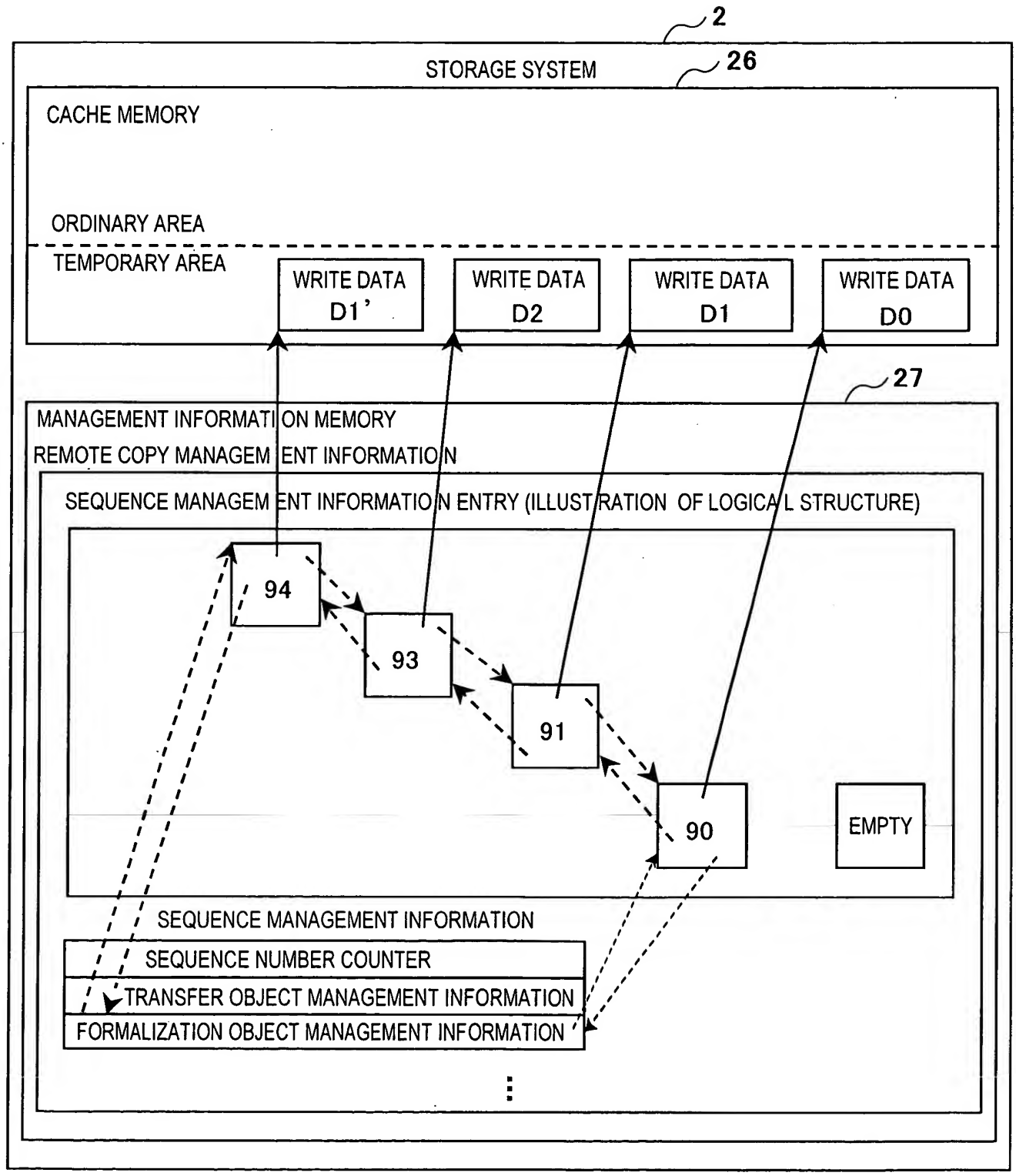

2
STORAGE SYSTEM
26
CACHE MEMORY
ORDINARY AREA
TEMPORARY AREA
WRITE DATA D1'
WRITE DATA D2
WRITE DATA D1
WRITE DATA D0
27
MANAGEMENT INFORMATION MEMORY
REMOTE COPY MANAGEMENT INFORMATION
SEQUENCE MANAGEMENT INFORMATION ENTRY (ILLUSTRATION OF LOGICAL STRUCTURE)
94
93
91
90
EMPTY
SEQUENCE MANAGEMENT INFORMATION
SEQUENCE NUMBER COUNTER
TRANSFER OBJECT MANAGEMENT INFORMATION
FORMALIZATION OBJECT MANAGEMENT INFORMATION

FIG.4A

REMOTE COPY OBJECT FLAG	OFF/COPY SOURCE/COPY TARGET
SEQUENCE MANAGEMENT INFORMATION NUMBER	1～N
NEWEST SEQUENCE NUMBER	M
PAIR STATE	COPYING/DUPLICATED/SUSPENDING
DIFFERENTIAL BIT MAP	010010 ・・・
COPY SOURCE INFORMATION	COPY SOURCE 1 ADDRESS INFORMATION
	COPY SOURCE 2 ADDRESS INFORMATION
COPY SOURCE VALID FLAG	1/2/TRANSITIONAL
COPY TARGET INFORMATION	COPY TARGET ADDRESS INFORMATION
READ/WRITE MODE	ORMAL/THROUGH/PENDING/DATA MIGRATING
DATA MIGRATION SOURCE INFORMATION	DATA MIGRATION SOURCE ADDRESS INFORMATION
DATA MIGRATION TARGET INFORMATION	DATA MIGRATION TARGET ADDRESS INFORMATION
DATA MIGRATION COMPLETION BIT MAP	010010 ・・・

FIG.4B

ADDRESS INFORMATION	STORAGE SYSTEM NUMBER	PORT NUMBER	VOLUME NUMBER
00011 ・・・	00101 ・・・	11101 ・・・	01001 ・・・

FIG.5

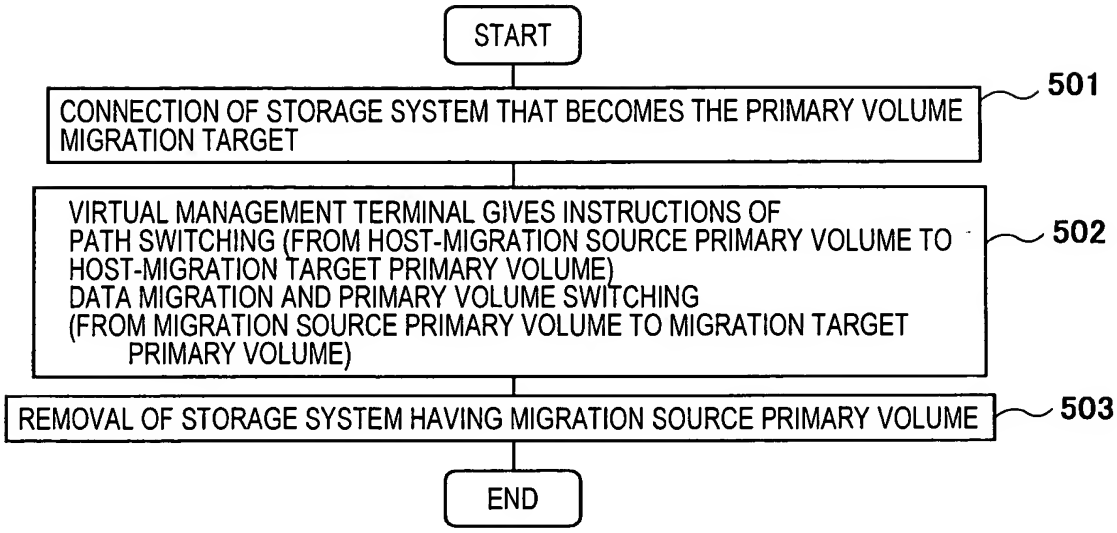

START
CONNECTION OF STORAGE SYSTEM THAT BECOMES THE PRIMARY VOLUME MIGRATION TARGET
501
VIRTUAL MANAGEMENT TERMINAL GIVES INSTRUCTIONS OF PATH SWITCHING (FROM HOST-MIGRATION SOURCE PRIMARY VOLUME TO HOST-MIGRATION TARGET PRIMARY VOLUME)
DATA MIGRATION AND PRIMARY VOLUME SWITCHING (FROM MIGRATION SOURCE PRIMARY VOLUME TO MIGRATION TARGET PRIMARY VOLUME)
502
REMOVAL OF STORAGE SYSTEM HAVING MIGRATION SOURCE PRIMARY VOLUME
503
END

FIG.6

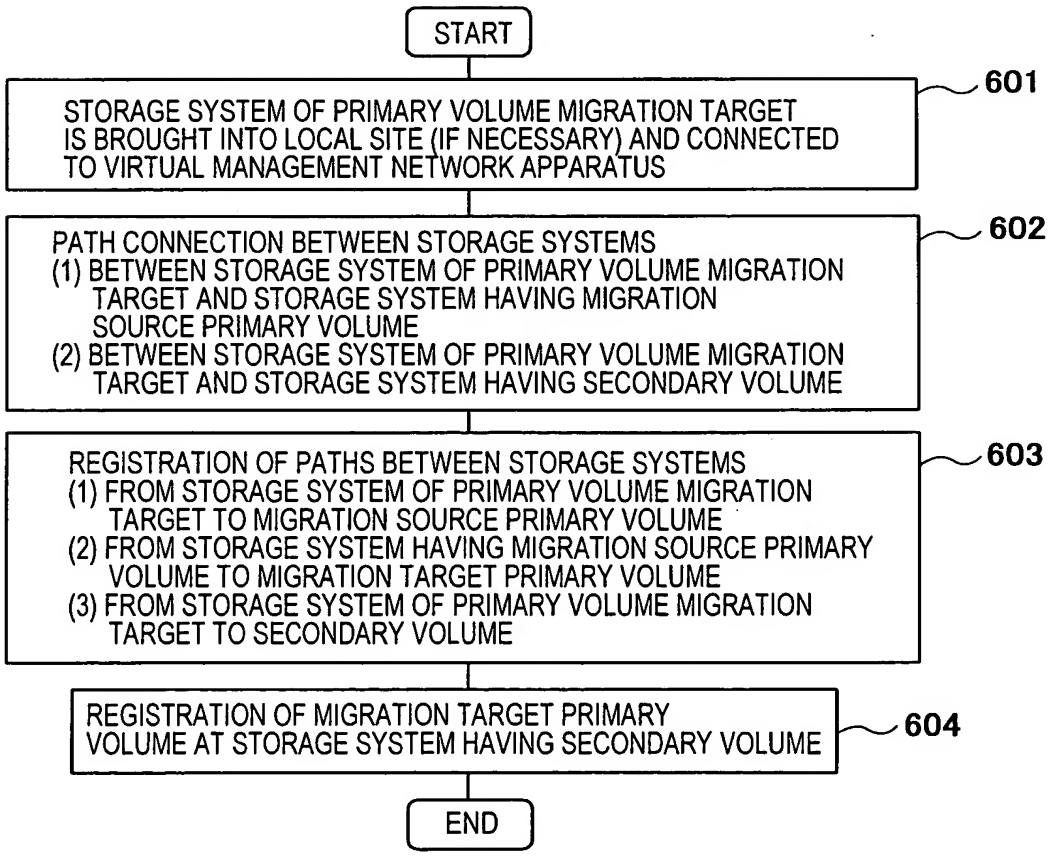

START
STORAGE SYSTEM OF PRIMARY VOLUME MIGRATION TARGET IS BROUGHT INTO LOCAL SITE (IF NECESSARY) AND CONNECTED TO VIRTUAL MANAGEMENT NETWORK APPARATUS
601
PATH CONNECTION BETWEEN STORAGE SYSTEMS
(1) BETWEEN STORAGE SYSTEM OF PRIMARY VOLUME MIGRATION TARGET AND STORAGE SYSTEM HAVING MIGRATION SOURCE PRIMARY VOLUME
(2) BETWEEN STORAGE SYSTEM OF PRIMARY VOLUME MIGRATION TARGET AND STORAGE SYSTEM HAVING SECONDARY VOLUME
602
REGISTRATION OF PATHS BETWEEN STORAGE SYSTEMS
(1) FROM STORAGE SYSTEM OF PRIMARY VOLUME MIGRATION TARGET TO MIGRATION SOURCE PRIMARY VOLUME
(2) FROM STORAGE SYSTEM HAVING MIGRATION SOURCE PRIMARY VOLUME TO MIGRATION TARGET PRIMARY VOLUME
(3) FROM STORAGE SYSTEM OF PRIMARY VOLUME MIGRATION TARGET TO SECONDARY VOLUME
603
REGISTRATION OF MIGRATION TARGET PRIMARY VOLUME AT STORAGE SYSTEM HAVING SECONDARY VOLUME
604
END

FIG.7

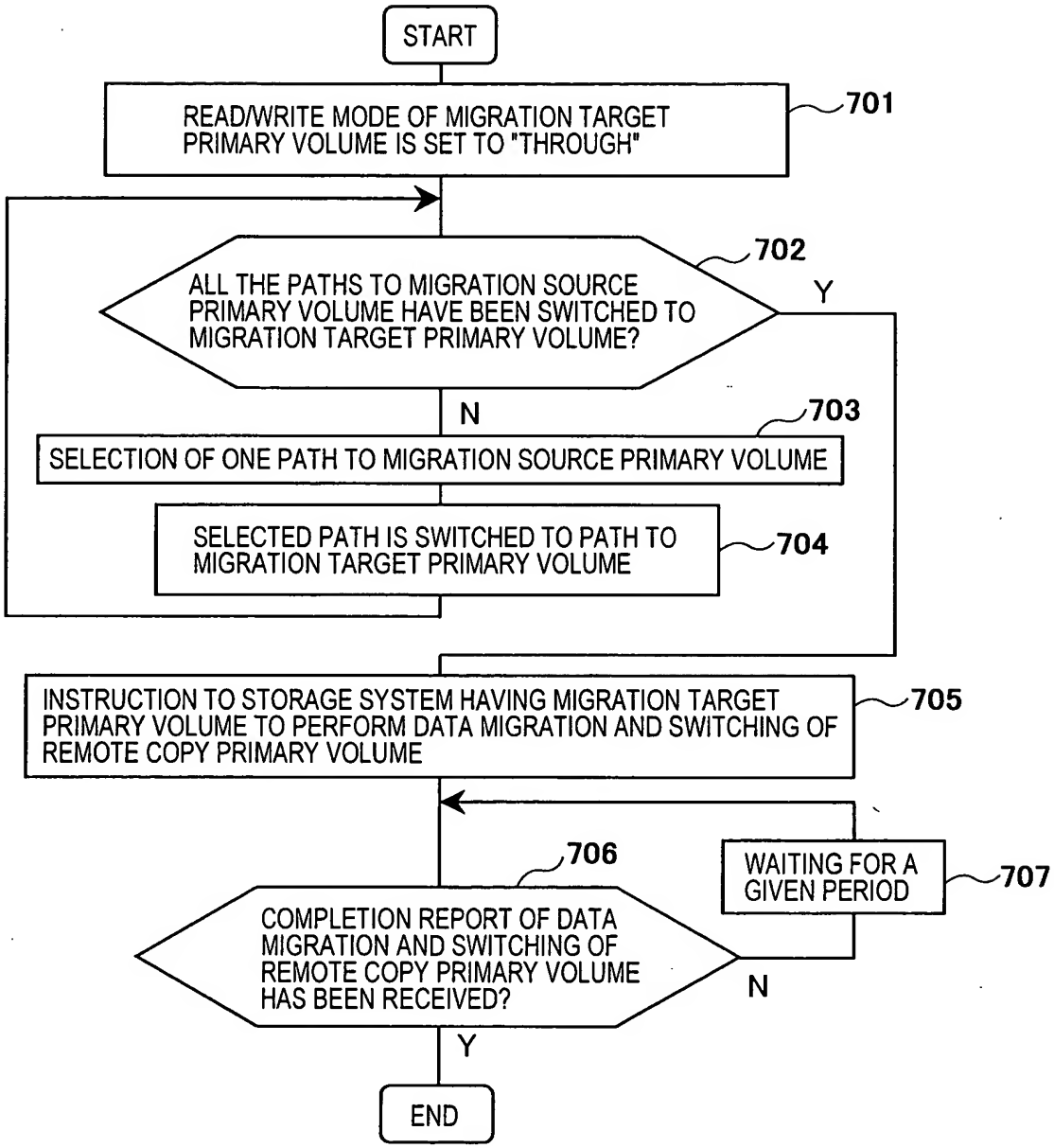

START
READ/WRITE MODE OF MIGRATION TARGET PRIMARY VOLUME IS SET TO "THROUGH"
701
ALL THE PATHS TO MIGRATION SOURCE PRIMARY VOLUME HAVE BEEN SWITCHED TO MIGRATION TARGET PRIMARY VOLUME?
702
Y
N
SELECTION OF ONE PATH TO MIGRATION SOURCE PRIMARY VOLUME
703
SELECTED PATH IS SWITCHED TO PATH TO MIGRATION TARGET PRIMARY VOLUME
704
INSTRUCTION TO STORAGE SYSTEM HAVING MIGRATION TARGET PRIMARY VOLUME TO PERFORM DATA MIGRATION AND SWITCHING OF REMOTE COPY PRIMARY VOLUME
705
706
COMPLETION REPORT OF DATA MIGRATION AND SWITCHING OF REMOTE COPY PRIMARY VOLUME HAS BEEN RECEIVED?
WAITING FOR A GIVEN PERIOD
707
N
Y
END

FIG.8A

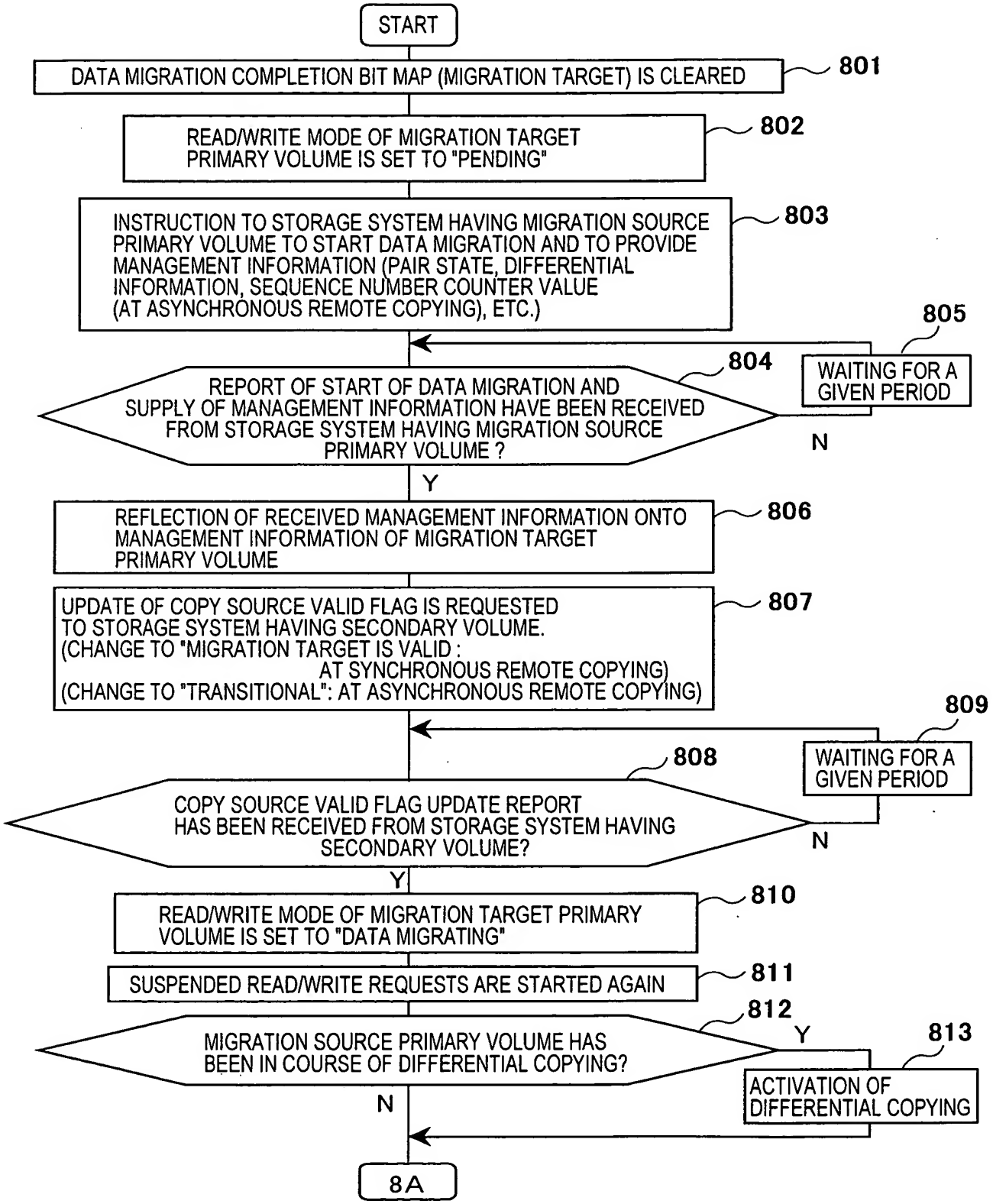

START
DATA MIGRATION COMPLETION BIT MAP (MIGRATION TARGET) IS CLEARED
801
READ/WRITE MODE OF MIGRATION TARGET PRIMARY VOLUME IS SET TO "PENDING"
802
INSTRUCTION TO STORAGE SYSTEM HAVING MIGRATION SOURCE PRIMARY VOLUME TO START DATA MIGRATION AND TO PROVIDE MANAGEMENT INFORMATION (PAIR STATE, DIFFERENTIAL INFORMATION, SEQUENCE NUMBER COUNTER VALUE (AT ASYNCHRONOUS REMOTE COPYING), ETC.)
803
805
WAITING FOR A GIVEN PERIOD
804
REPORT OF START OF DATA MIGRATION AND SUPPLY OF MANAGEMENT INFORMATION HAVE BEEN RECEIVED FROM STORAGE SYSTEM HAVING MIGRATION SOURCE PRIMARY VOLUME ?
N
Y
REFLECTION OF RECEIVED MANAGEMENT INFORMATION ONTO MANAGEMENT INFORMATION OF MIGRATION TARGET PRIMARY VOLUME
806
UPDATE OF COPY SOURCE VALID FLAG IS REQUESTED TO STORAGE SYSTEM HAVING SECONDARY VOLUME.
(CHANGE TO "MIGRATION TARGET IS VALID : AT SYNCHRONOUS REMOTE COPYING)
(CHANGE TO "TRANSITIONAL": AT ASYNCHRONOUS REMOTE COPYING)
807
809
WAITING FOR A GIVEN PERIOD
808
COPY SOURCE VALID FLAG UPDATE REPORT HAS BEEN RECEIVED FROM STORAGE SYSTEM HAVING SECONDARY VOLUME?
N
Y
READ/WRITE MODE OF MIGRATION TARGET PRIMARY VOLUME IS SET TO "DATA MIGRATING"
810
SUSPENDED READ/WRITE REQUESTS ARE STARTED AGAIN
811
812
MIGRATION SOURCE PRIMARY VOLUME HAS BEEN IN COURSE OF DIFFERENTIAL COPYING?
Y
813
ACTIVATION OF DIFFERENTIAL COPYING
N
8A

FIG.8B

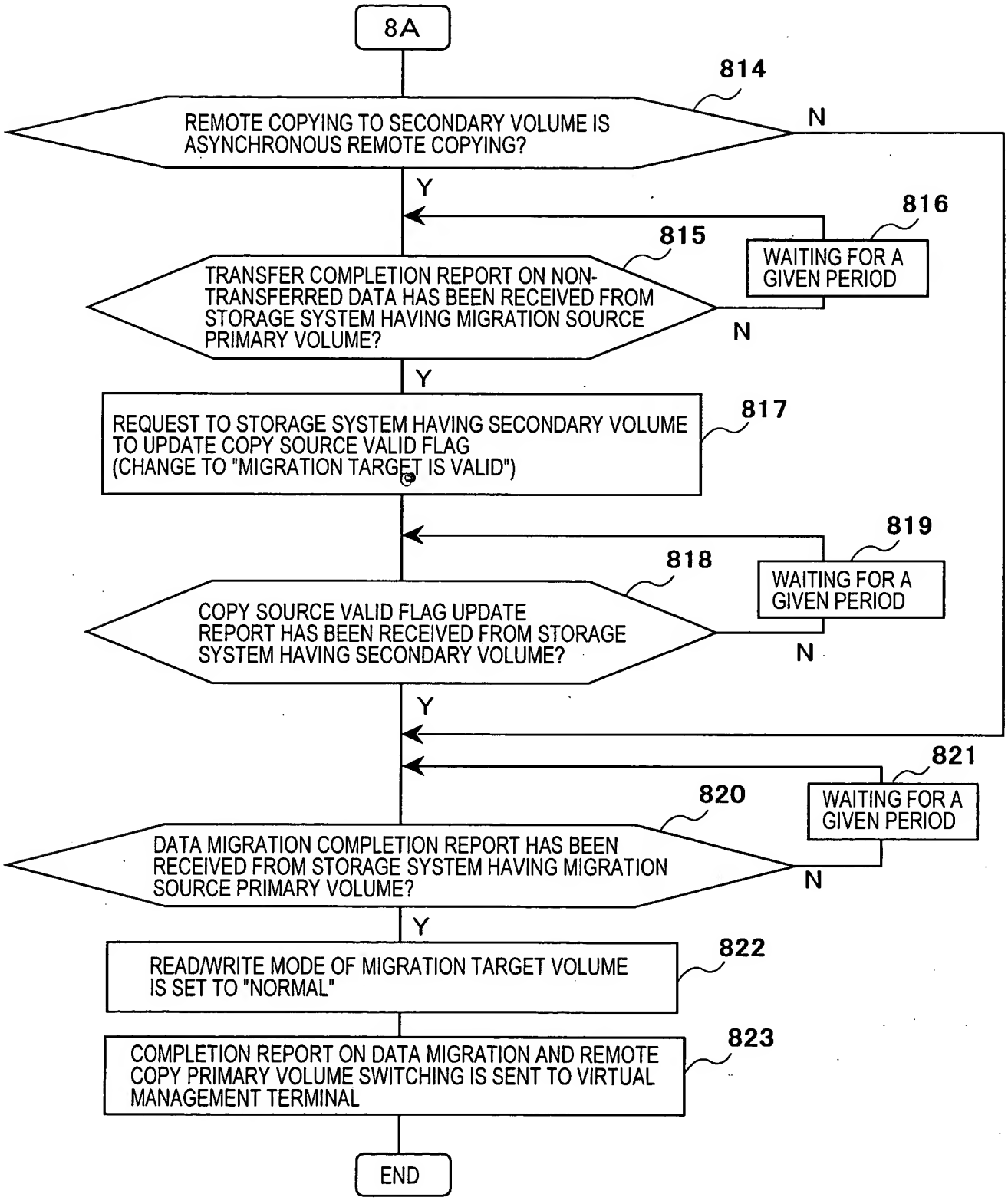

8A
814
REMOTE COPYING TO SECONDARY VOLUME IS ASYNCHRONOUS REMOTE COPYING?
N
Y
816
WAITING FOR A GIVEN PERIOD
815
TRANSFER COMPLETION REPORT ON NON-TRANSFERRED DATA HAS BEEN RECEIVED FROM STORAGE SYSTEM HAVING MIGRATION SOURCE PRIMARY VOLUME?
N
Y
817
REQUEST TO STORAGE SYSTEM HAVING SECONDARY VOLUME TO UPDATE COPY SOURCE VALID FLAG (CHANGE TO "MIGRATION TARGET IS VALID")
819
WAITING FOR A GIVEN PERIOD
818
COPY SOURCE VALID FLAG UPDATE REPORT HAS BEEN RECEIVED FROM STORAGE SYSTEM HAVING SECONDARY VOLUME?
N
Y
821
WAITING FOR A GIVEN PERIOD
820
DATA MIGRATION COMPLETION REPORT HAS BEEN RECEIVED FROM STORAGE SYSTEM HAVING MIGRATION SOURCE PRIMARY VOLUME?
N
Y
822
READ/WRITE MODE OF MIGRATION TARGET VOLUME IS SET TO "NORMAL"
823
COMPLETION REPORT ON DATA MIGRATION AND REMOTE COPY PRIMARY VOLUME SWITCHING IS SENT TO VIRTUAL MANAGEMENT TERMINAL
END

FIG.9

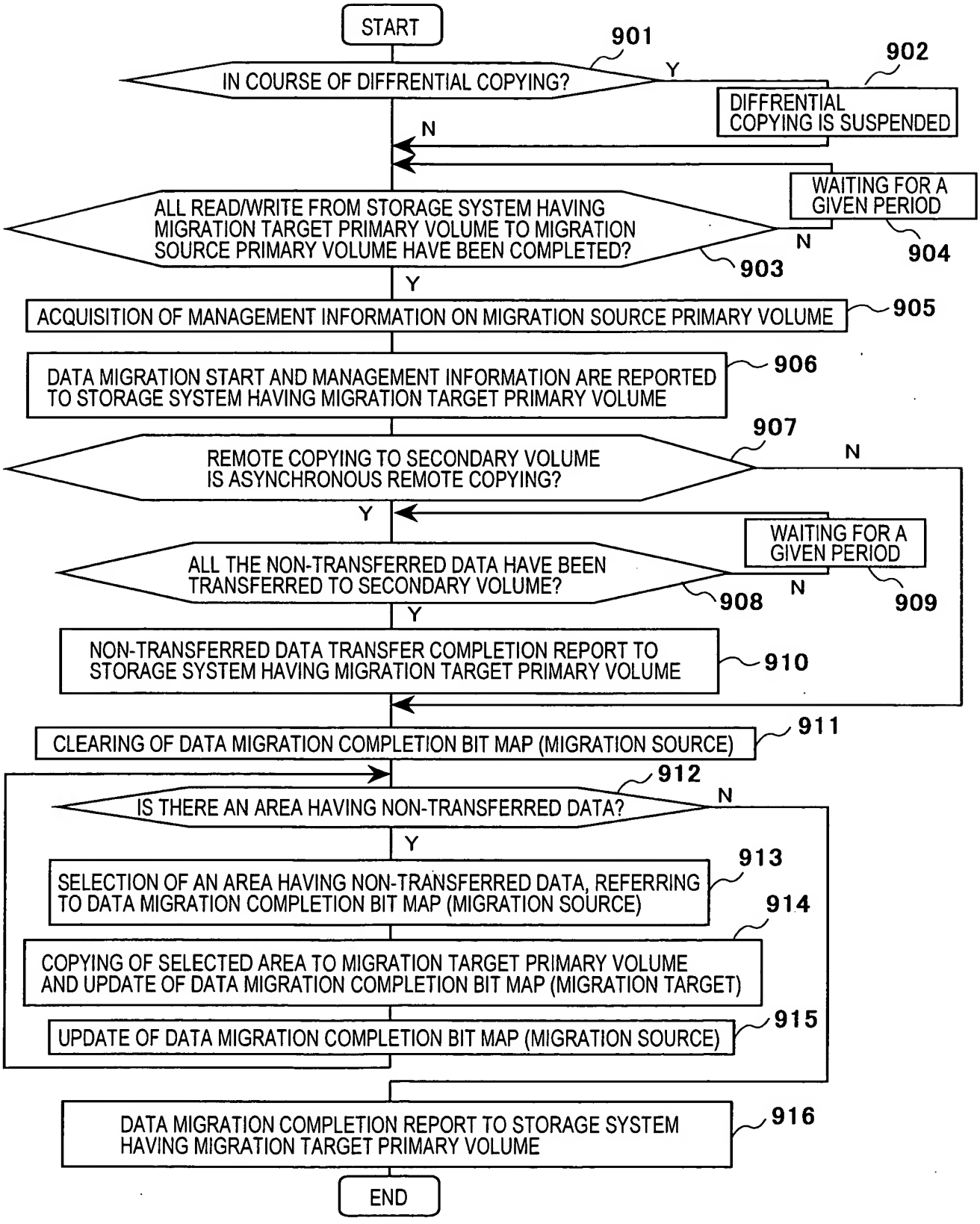

START
901
IN COURSE OF DIFFRENTIAL COPYING?
Y
902
DIFFRENTIAL COPYING IS SUSPENDED
N
WAITING FOR A GIVEN PERIOD
ALL READ/WRITE FROM STORAGE SYSTEM HAVING MIGRATION TARGET PRIMARY VOLUME TO MIGRATION SOURCE PRIMARY VOLUME HAVE BEEN COMPLETED?
N
904
903
Y
ACQUISITION OF MANAGEMENT INFORMATION ON MIGRATION SOURCE PRIMARY VOLUME
905
DATA MIGRATION START AND MANAGEMENT INFORMATION ARE REPORTED TO STORAGE SYSTEM HAVING MIGRATION TARGET PRIMARY VOLUME
906
907
REMOTE COPYING TO SECONDARY VOLUME IS ASYNCHRONOUS REMOTE COPYING?
N
Y
WAITING FOR A GIVEN PERIOD
ALL THE NON-TRANSFERRED DATA HAVE BEEN TRANSFERRED TO SECONDARY VOLUME?
N
909
908
Y
NON-TRANSFERRED DATA TRANSFER COMPLETION REPORT TO STORAGE SYSTEM HAVING MIGRATION TARGET PRIMARY VOLUME
910
CLEARING OF DATA MIGRATION COMPLETION BIT MAP (MIGRATION SOURCE)
911
912
IS THERE AN AREA HAVING NON-TRANSFERRED DATA?
N
Y
913
SELECTION OF AN AREA HAVING NON-TRANSFERRED DATA, REFERRING TO DATA MIGRATION COMPLETION BIT MAP (MIGRATION SOURCE)
914
COPYING OF SELECTED AREA TO MIGRATION TARGET PRIMARY VOLUME AND UPDATE OF DATA MIGRATION COMPLETION BIT MAP (MIGRATION TARGET)
915
UPDATE OF DATA MIGRATION COMPLETION BIT MAP (MIGRATION SOURCE)
DATA MIGRATION COMPLETION REPORT TO STORAGE SYSTEM HAVING MIGRATION TARGET PRIMARY VOLUME
916
END

FIG.10

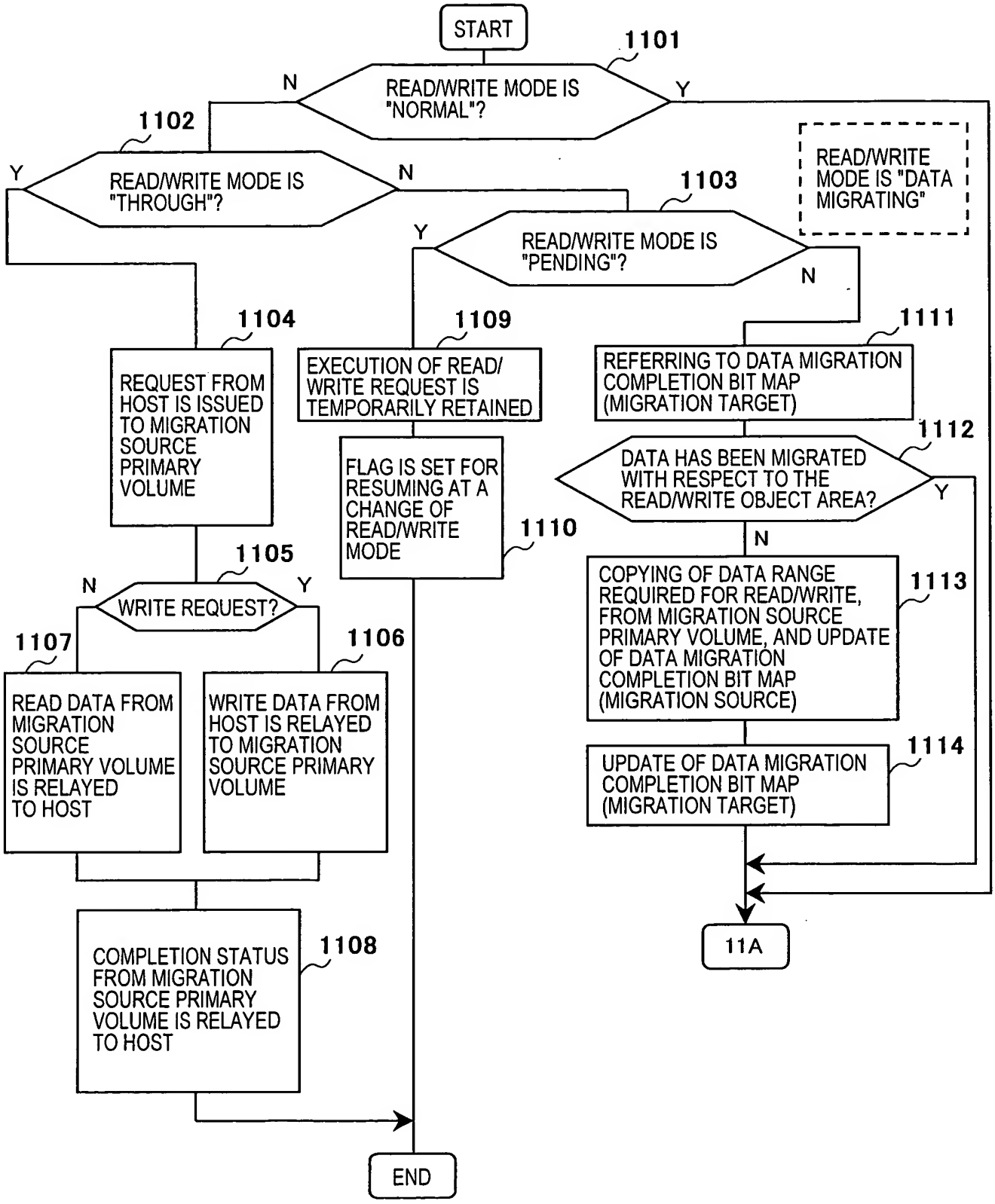

START
1101
READ/WRITE MODE IS "NORMAL"?
N
Y
1102
READ/WRITE MODE IS "THROUGH"?
Y
N
1103
READ/WRITE MODE IS "PENDING"?
Y
N
READ/WRITE MODE IS "DATA MIGRATING"
1104
REQUEST FROM HOST IS ISSUED TO MIGRATION SOURCE PRIMARY VOLUME
1109
EXECUTION OF READ/WRITE REQUEST IS TEMPORARILY RETAINED
1111
REFERRING TO DATA MIGRATION COMPLETION BIT MAP (MIGRATION TARGET)
1112
DATA HAS BEEN MIGRATED WITH RESPECT TO THE READ/WRITE OBJECT AREA?
Y
N
1110
FLAG IS SET FOR RESUMING AT A CHANGE OF READ/WRITE MODE
1105
WRITE REQUEST?
N
Y
1107
READ DATA FROM MIGRATION SOURCE PRIMARY VOLUME IS RELAYED TO HOST
1106
WRITE DATA FROM HOST IS RELAYED TO MIGRATION SOURCE PRIMARY VOLUME
1113
COPYING OF DATA RANGE REQUIRED FOR READ/WRITE, FROM MIGRATION SOURCE PRIMARY VOLUME, AND UPDATE OF DATA MIGRATION COMPLETION BIT MAP (MIGRATION SOURCE)
1114
UPDATE OF DATA MIGRATION COMPLETION BIT MAP (MIGRATION TARGET)
1108
COMPLETION STATUS FROM MIGRATION SOURCE PRIMARY VOLUME IS RELAYED TO HOST
11A
END

FIG.11

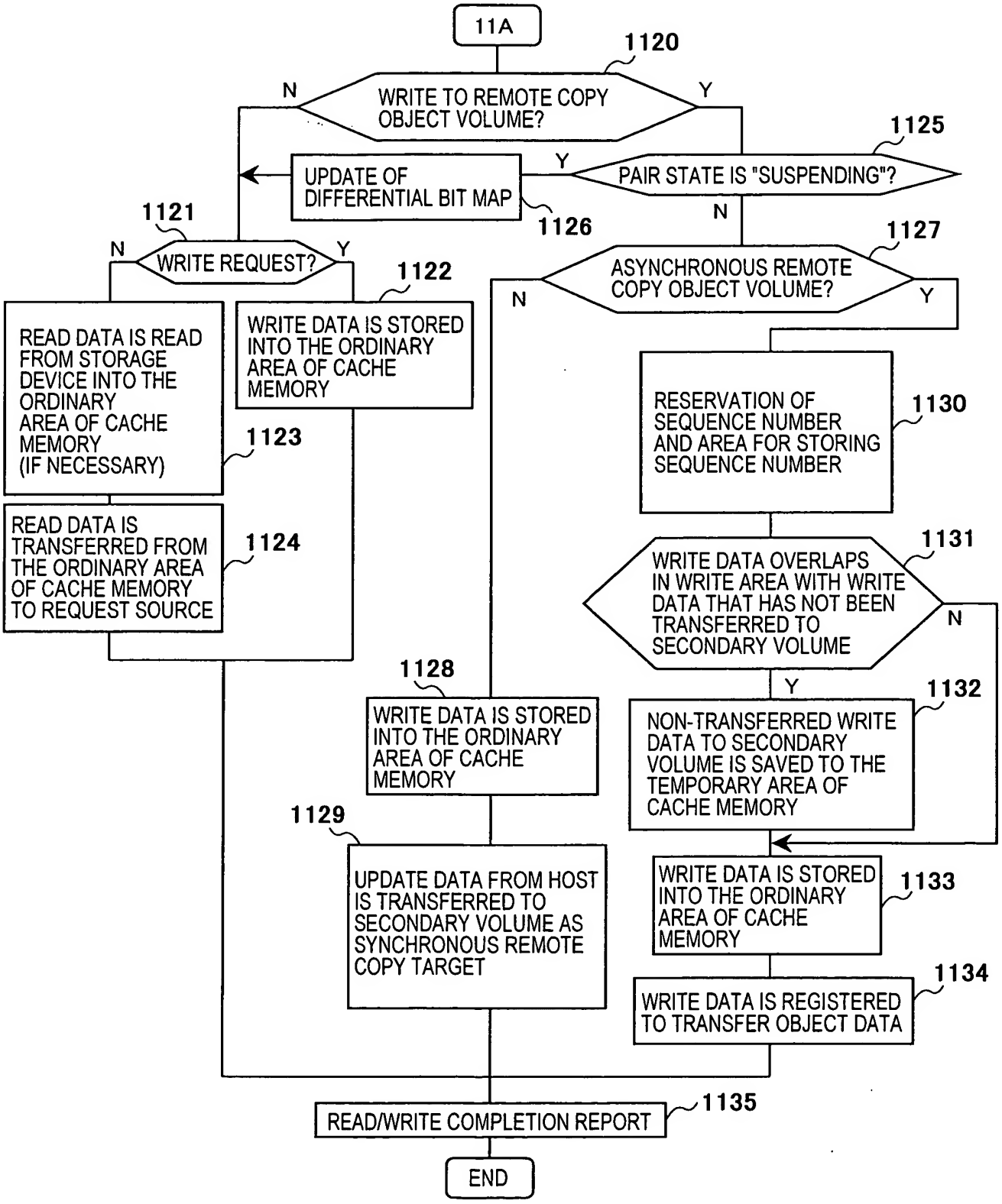

11A
1120
WRITE TO REMOTE COPY OBJECT VOLUME?
N
Y
1125
PAIR STATE IS "SUSPENDING"?
Y
UPDATE OF DIFFERENTIAL BIT MAP
1126
N
1121
WRITE REQUEST?
N
Y
1127
ASYNCHRONOUS REMOTE COPY OBJECT VOLUME?
N
Y
1122
READ DATA IS READ FROM STORAGE DEVICE INTO THE ORDINARY AREA OF CACHE MEMORY (IF NECESSARY)
1123
WRITE DATA IS STORED INTO THE ORDINARY AREA OF CACHE MEMORY
RESERVATION OF SEQUENCE NUMBER AND AREA FOR STORING SEQUENCE NUMBER
1130
READ DATA IS TRANSFERRED FROM THE ORDINARY AREA OF CACHE MEMORY TO REQUEST SOURCE
1124
1131
WRITE DATA OVERLAPS IN WRITE AREA WITH WRITE DATA THAT HAS NOT BEEN TRANSFERRED TO SECONDARY VOLUME
N
Y
1128
1132
WRITE DATA IS STORED INTO THE ORDINARY AREA OF CACHE MEMORY
NON-TRANSFERRED WRITE DATA TO SECONDARY VOLUME IS SAVED TO THE TEMPORARY AREA OF CACHE MEMORY
1129
UPDATE DATA FROM HOST IS TRANSFERRED TO SECONDARY VOLUME AS SYNCHRONOUS REMOTE COPY TARGET
WRITE DATA IS STORED INTO THE ORDINARY AREA OF CACHE MEMORY
1133
1134
WRITE DATA IS REGISTERED TO TRANSFER OBJECT DATA
READ/WRITE COMPLETION REPORT
1135
END

FIG.12

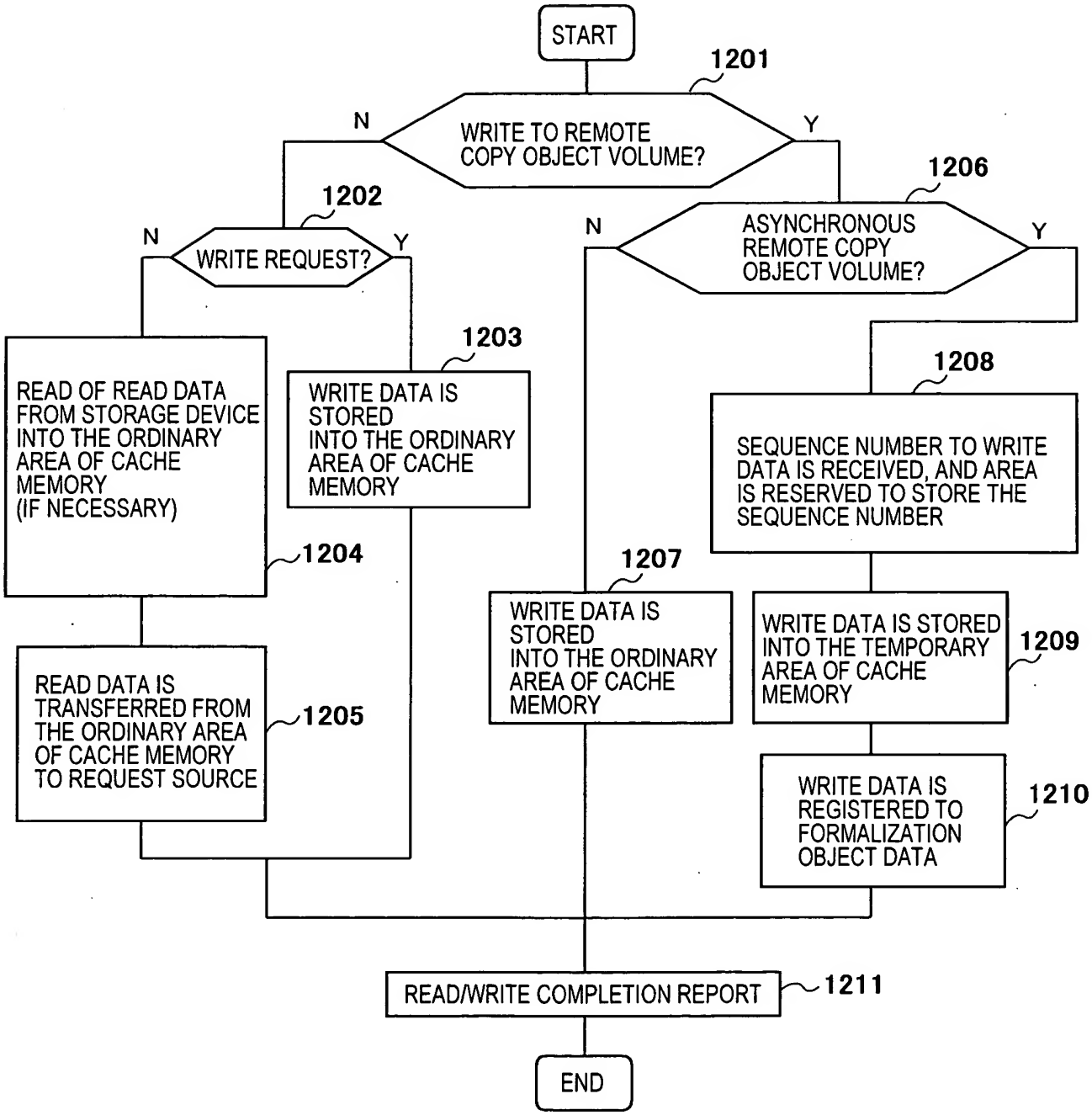

START
1201
WRITE TO REMOTE COPY OBJECT VOLUME?
N
Y
1202
WRITE REQUEST?
N
Y
1206
ASYNCHRONOUS REMOTE COPY OBJECT VOLUME?
N
Y
READ OF READ DATA FROM STORAGE DEVICE INTO THE ORDINARY AREA OF CACHE MEMORY (IF NECESSARY)
1204
1203
WRITE DATA IS STORED INTO THE ORDINARY AREA OF CACHE MEMORY
1208
SEQUENCE NUMBER TO WRITE DATA IS RECEIVED, AND AREA IS RESERVED TO STORE THE SEQUENCE NUMBER
1207
WRITE DATA IS STORED INTO THE ORDINARY AREA OF CACHE MEMORY
WRITE DATA IS STORED INTO THE TEMPORARY AREA OF CACHE MEMORY
1209
READ DATA IS TRANSFERRED FROM THE ORDINARY AREA OF CACHE MEMORY TO REQUEST SOURCE
1205
WRITE DATA IS REGISTERED TO FORMALIZATION OBJECT DATA
1210
READ/WRITE COMPLETION REPORT
1211
END

FIG.13

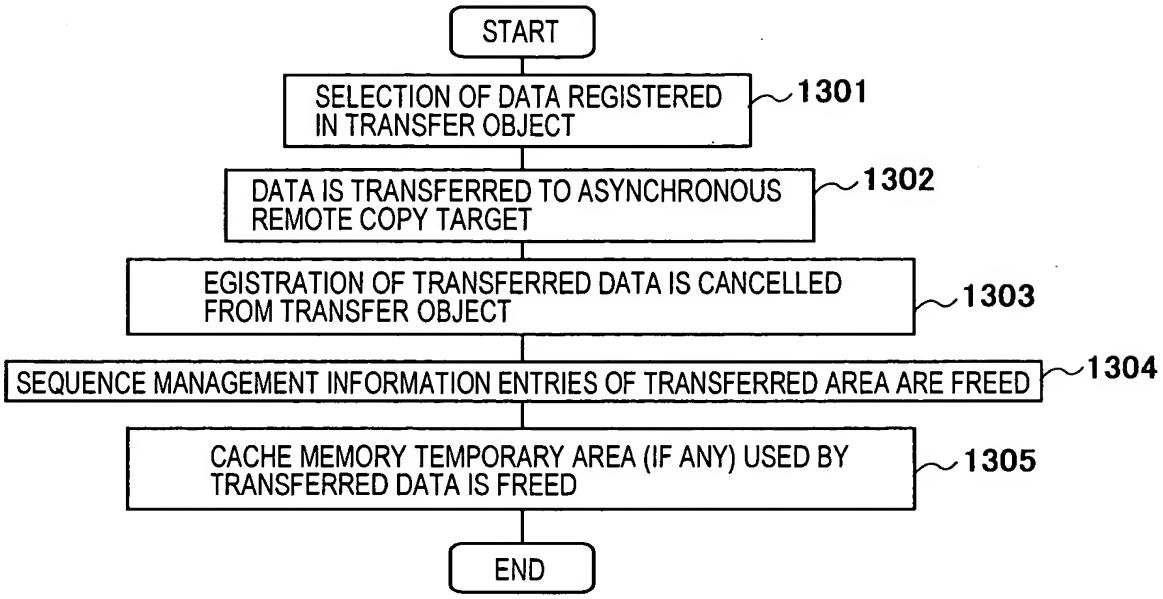

START
SELECTION OF DATA REGISTERED IN TRANSFER OBJECT
1301
DATA IS TRANSFERRED TO ASYNCHRONOUS REMOTE COPY TARGET
1302
EGISTRATION OF TRANSFERRED DATA IS CANCELLED FROM TRANSFER OBJECT
1303
SEQUENCE MANAGEMENT INFORMATION ENTRIES OF TRANSFERRED AREA ARE FREED
1304
CACHE MEMORY TEMPORARY AREA (IF ANY) USED BY TRANSFERRED DATA IS FREED
1305
END

FIG.14

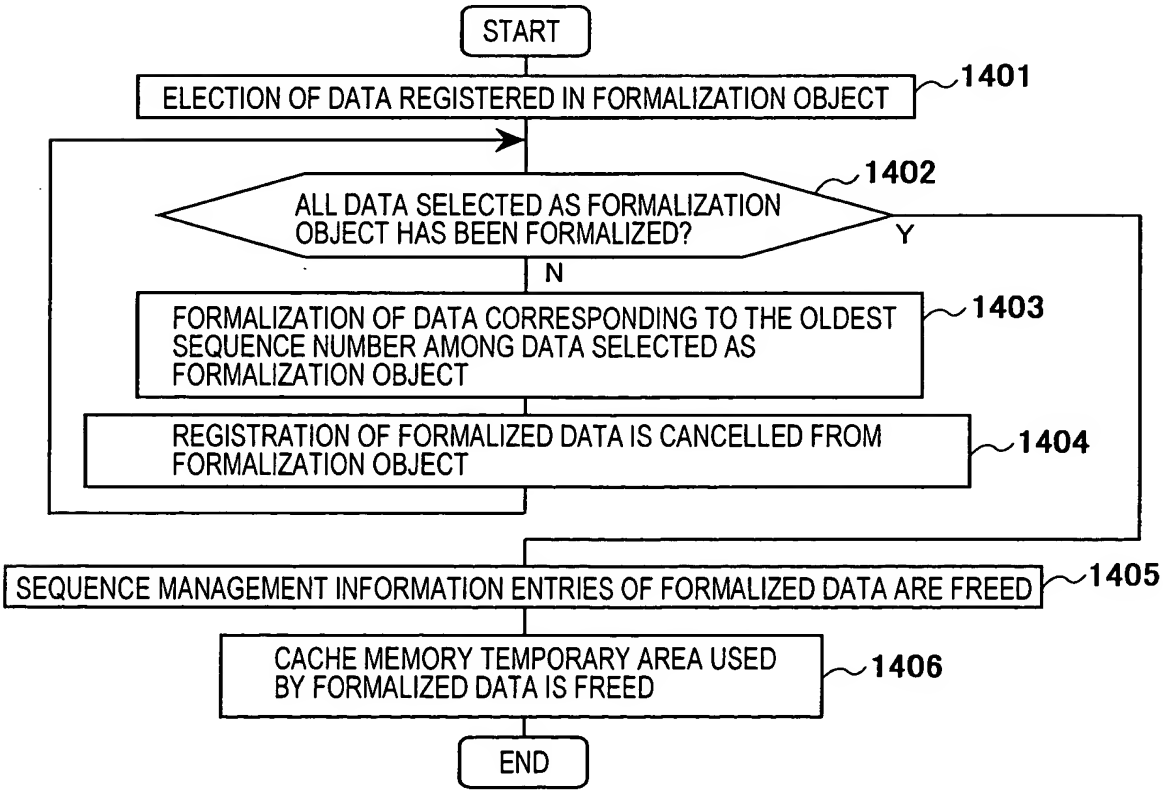

START
ELECTION OF DATA REGISTERED IN FORMALIZATION OBJECT
1401
ALL DATA SELECTED AS FORMALIZATION OBJECT HAS BEEN FORMALIZED?
1402
Y
N
FORMALIZATION OF DATA CORRESPONDING TO THE OLDEST SEQUENCE NUMBER AMONG DATA SELECTED AS FORMALIZATION OBJECT
1403
REGISTRATION OF FORMALIZED DATA IS CANCELLED FROM FORMALIZATION OBJECT
1404
SEQUENCE MANAGEMENT INFORMATION ENTRIES OF FORMALIZED DATA ARE FREED
1405
CACHE MEMORY TEMPORARY AREA USED BY FORMALIZED DATA IS FREED
1406
END

FIG.15

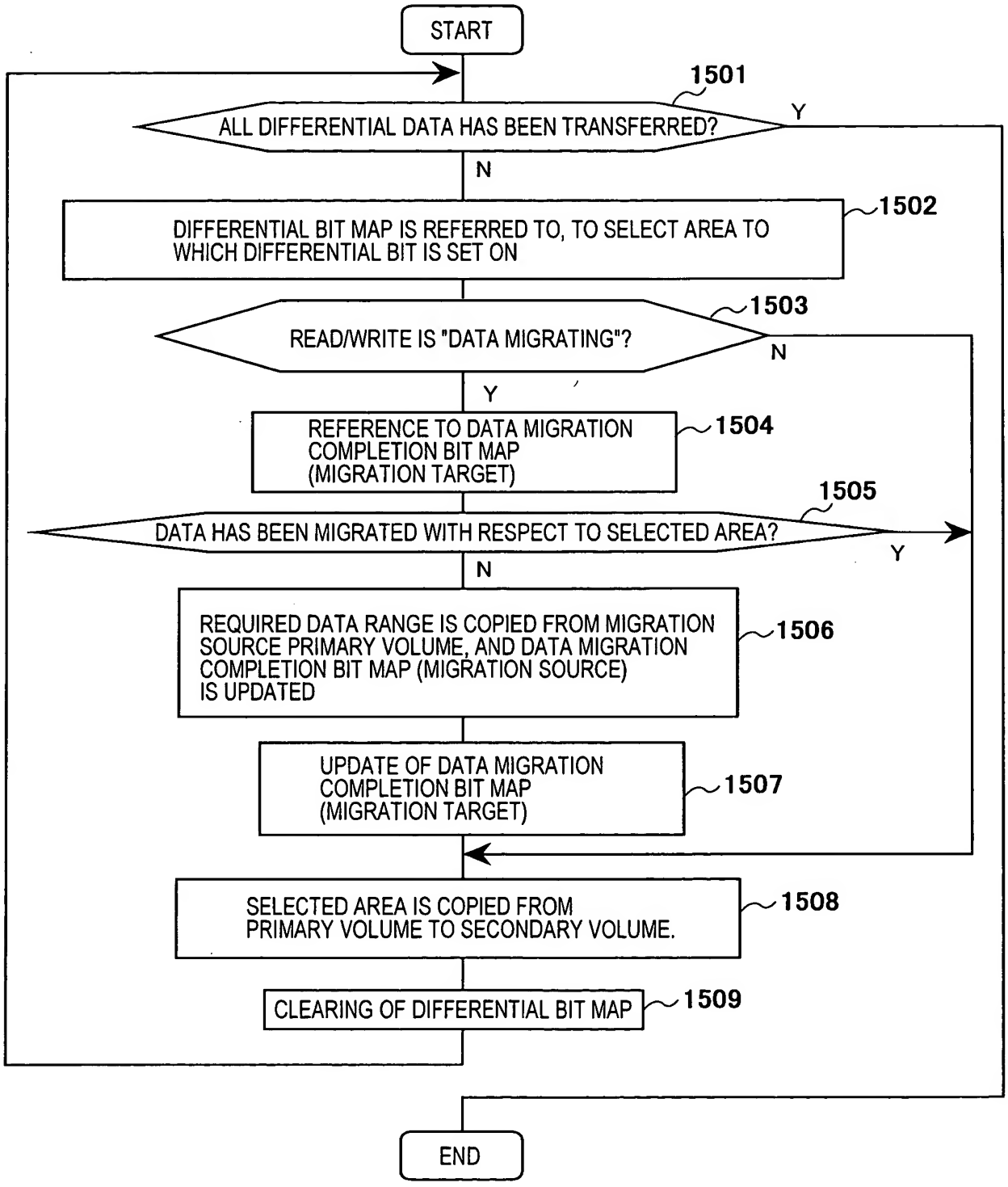

START
1501
ALL DIFFERENTIAL DATA HAS BEEN TRANSFERRED?
Y
N
DIFFERENTIAL BIT MAP IS REFERRED TO, TO SELECT AREA TO WHICH DIFFERENTIAL BIT IS SET ON
1502
1503
READ/WRITE IS "DATA MIGRATING"?
N
Y
REFERENCE TO DATA MIGRATION COMPLETION BIT MAP (MIGRATION TARGET)
1504
1505
DATA HAS BEEN MIGRATED WITH RESPECT TO SELECTED AREA?
Y
N
REQUIRED DATA RANGE IS COPIED FROM MIGRATION SOURCE PRIMARY VOLUME, AND DATA MIGRATION COMPLETION BIT MAP (MIGRATION SOURCE) IS UPDATED
1506
UPDATE OF DATA MIGRATION COMPLETION BIT MAP (MIGRATION TARGET)
1507
SELECTED AREA IS COPIED FROM PRIMARY VOLUME TO SECONDARY VOLUME.
1508
CLEARING OF DIFFERENTIAL BIT MAP
1509
END

FIG.16

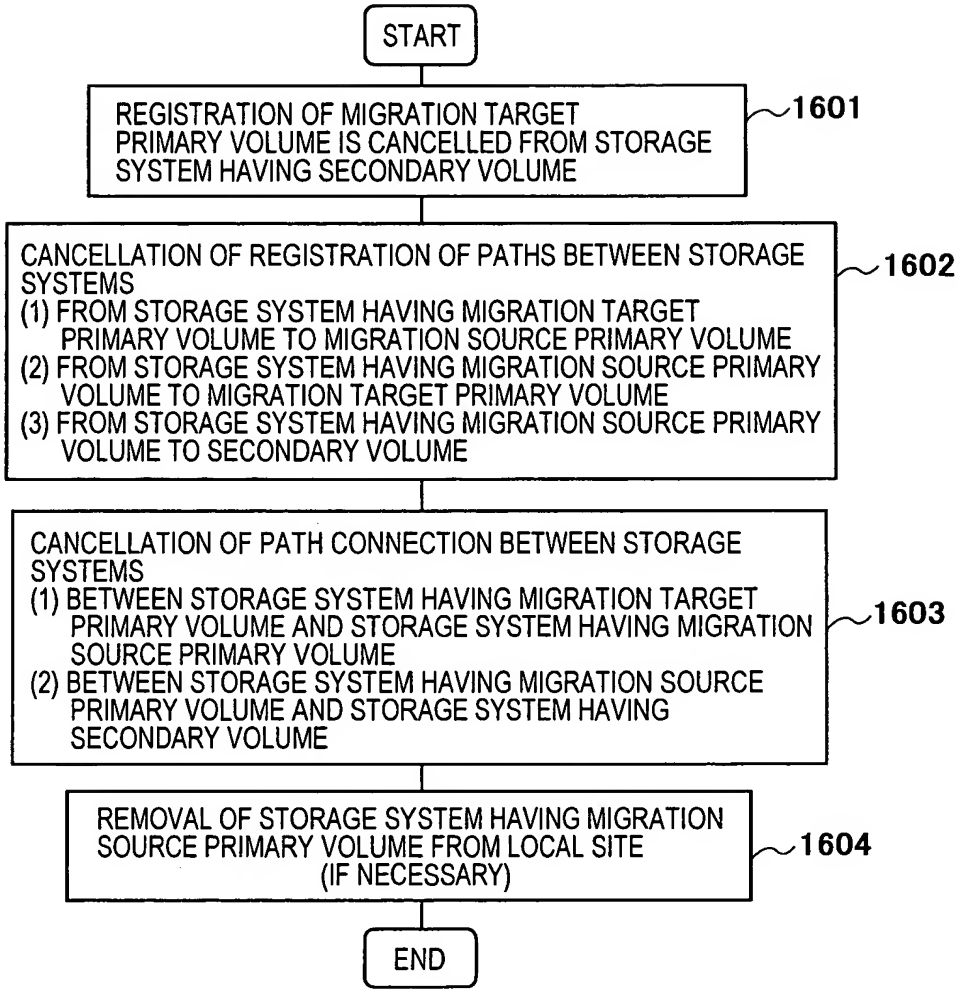

START
REGISTRATION OF MIGRATION TARGET PRIMARY VOLUME IS CANCELLED FROM STORAGE SYSTEM HAVING SECONDARY VOLUME
1601
CANCELLATION OF REGISTRATION OF PATHS BETWEEN STORAGE SYSTEMS
(1) FROM STORAGE SYSTEM HAVING MIGRATION TARGET PRIMARY VOLUME TO MIGRATION SOURCE PRIMARY VOLUME
(2) FROM STORAGE SYSTEM HAVING MIGRATION SOURCE PRIMARY VOLUME TO MIGRATION TARGET PRIMARY VOLUME
(3) FROM STORAGE SYSTEM HAVING MIGRATION SOURCE PRIMARY VOLUME TO SECONDARY VOLUME
1602
CANCELLATION OF PATH CONNECTION BETWEEN STORAGE SYSTEMS
(1) BETWEEN STORAGE SYSTEM HAVING MIGRATION TARGET PRIMARY VOLUME AND STORAGE SYSTEM HAVING MIGRATION SOURCE PRIMARY VOLUME
(2) BETWEEN STORAGE SYSTEM HAVING MIGRATION SOURCE PRIMARY VOLUME AND STORAGE SYSTEM HAVING SECONDARY VOLUME
1603
REMOVAL OF STORAGE SYSTEM HAVING MIGRATION SOURCE PRIMARY VOLUME FROM LOCAL SITE (IF NECESSARY)
1604
END

FIG.17

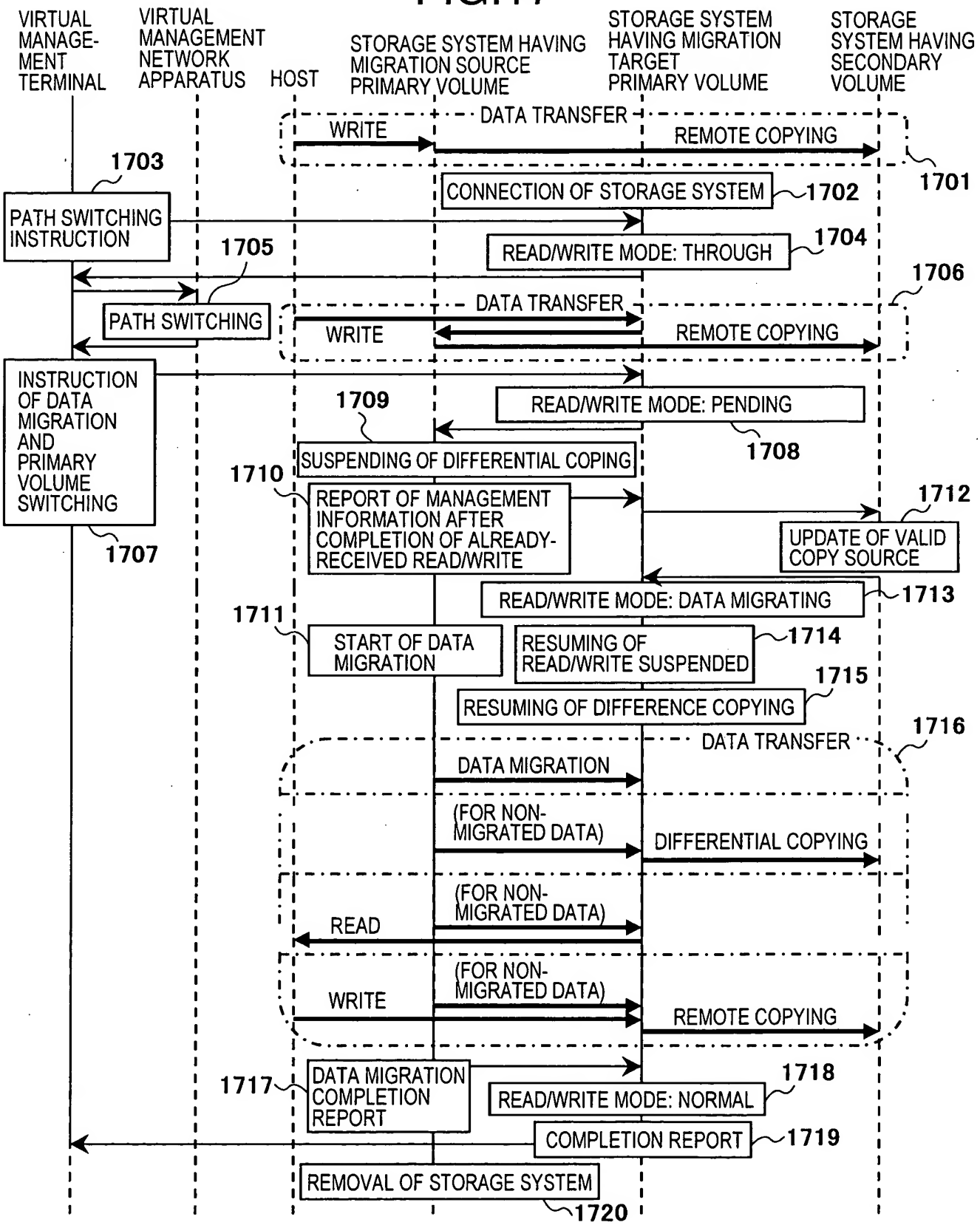

VIRTUAL MANAGE-MENT TERMINAL
VIRTUAL MANAGEMENT NETWORK APPARATUS
HOST
STORAGE SYSTEM HAVING MIGRATION SOURCE PRIMARY VOLUME
STORAGE SYSTEM HAVING MIGRATION TARGET PRIMARY VOLUME
STORAGE SYSTEM HAVING SECONDARY VOLUME
DATA TRANSFER
WRITE
REMOTE COPYING
1701
1703
PATH SWITCHING INSTRUCTION
CONNECTION OF STORAGE SYSTEM
1702
READ/WRITE MODE: THROUGH
1704
1705
PATH SWITCHING
1706
DATA TRANSFER
WRITE
REMOTE COPYING
INSTRUCTION OF DATA MIGRATION AND PRIMARY VOLUME SWITCHING
1707
1709
READ/WRITE MODE: PENDING
1708
SUSPENDING OF DIFFERENTIAL COPING
1710
REPORT OF MANAGEMENT INFORMATION AFTER COMPLETION OF ALREADY-RECEIVED READ/WRITE
1712
UPDATE OF VALID COPY SOURCE
READ/WRITE MODE: DATA MIGRATING
1713
1711
START OF DATA MIGRATION
RESUMING OF READ/WRITE SUSPENDED
1714
1715
RESUMING OF DIFFERENCE COPYING
1716
DATA TRANSFER
DATA MIGRATION
(FOR NON-MIGRATED DATA)
DIFFERENTIAL COPYING
(FOR NON-MIGRATED DATA)
READ
(FOR NON-MIGRATED DATA)
WRITE
REMOTE COPYING
1717
DATA MIGRATION COMPLETION REPORT
1718
READ/WRITE MODE: NORMAL
COMPLETION REPORT
1719
REMOVAL OF STORAGE SYSTEM
1720

FIG.18

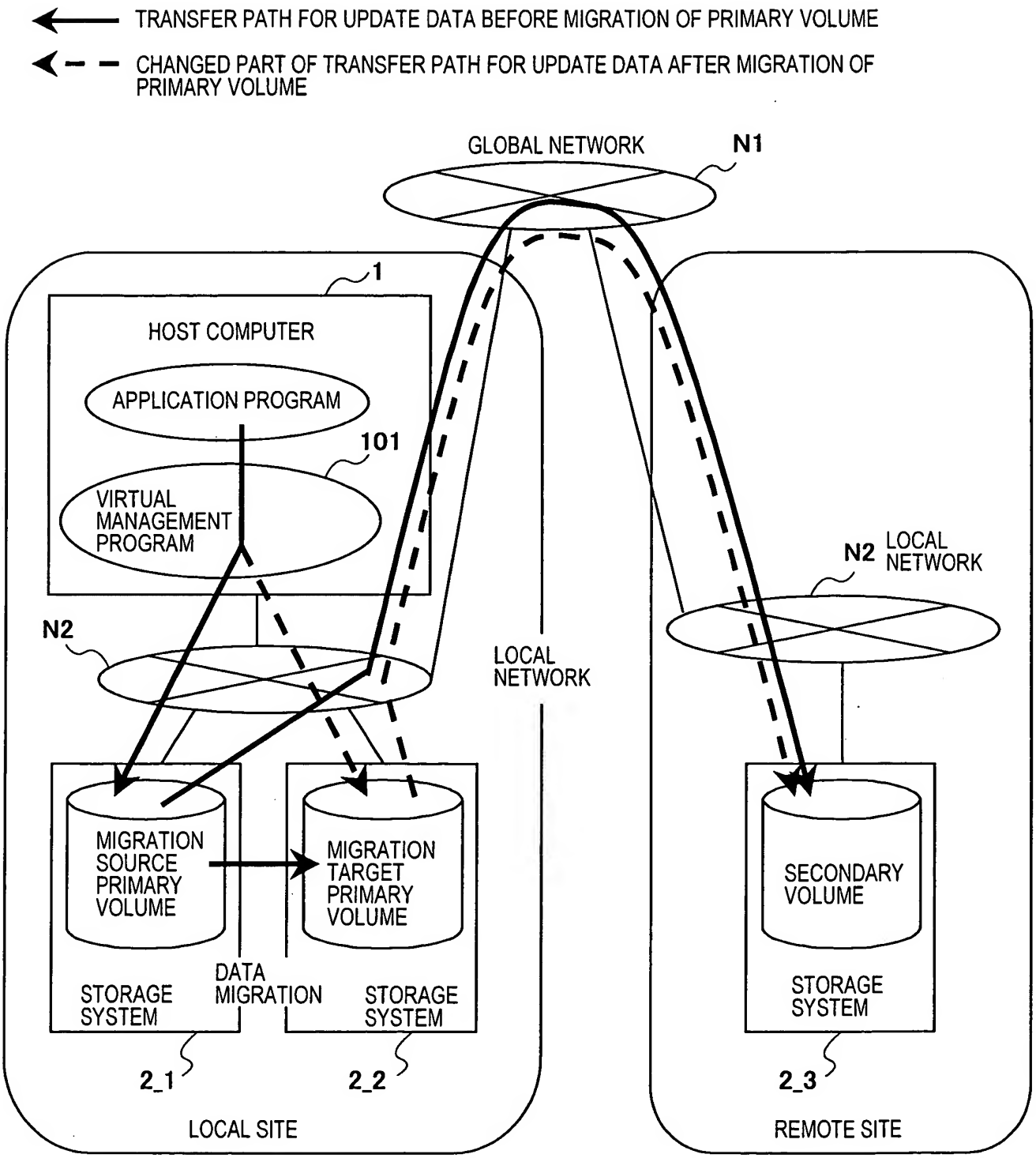

TRANSFER PATH FOR UPDATE DATA BEFORE MIGRATION OF PRIMARY VOLUME
CHANGED PART OF TRANSFER PATH FOR UPDATE DATA AFTER MIGRATION OF PRIMARY VOLUME
GLOBAL NETWORK
N1
1
HOST COMPUTER
APPLICATION PROGRAM
101
VIRTUAL MANAGEMENT PROGRAM
N2
LOCAL NETWORK
N2
LOCAL NETWORK
MIGRATION SOURCE PRIMARY VOLUME
MIGRATION TARGET PRIMARY VOLUME
DATA MIGRATION
STORAGE SYSTEM
STORAGE SYSTEM
2_1
2_2
LOCAL SITE
SECONDARY VOLUME
STORAGE SYSTEM
2_3
REMOTE SITE

FIG.19

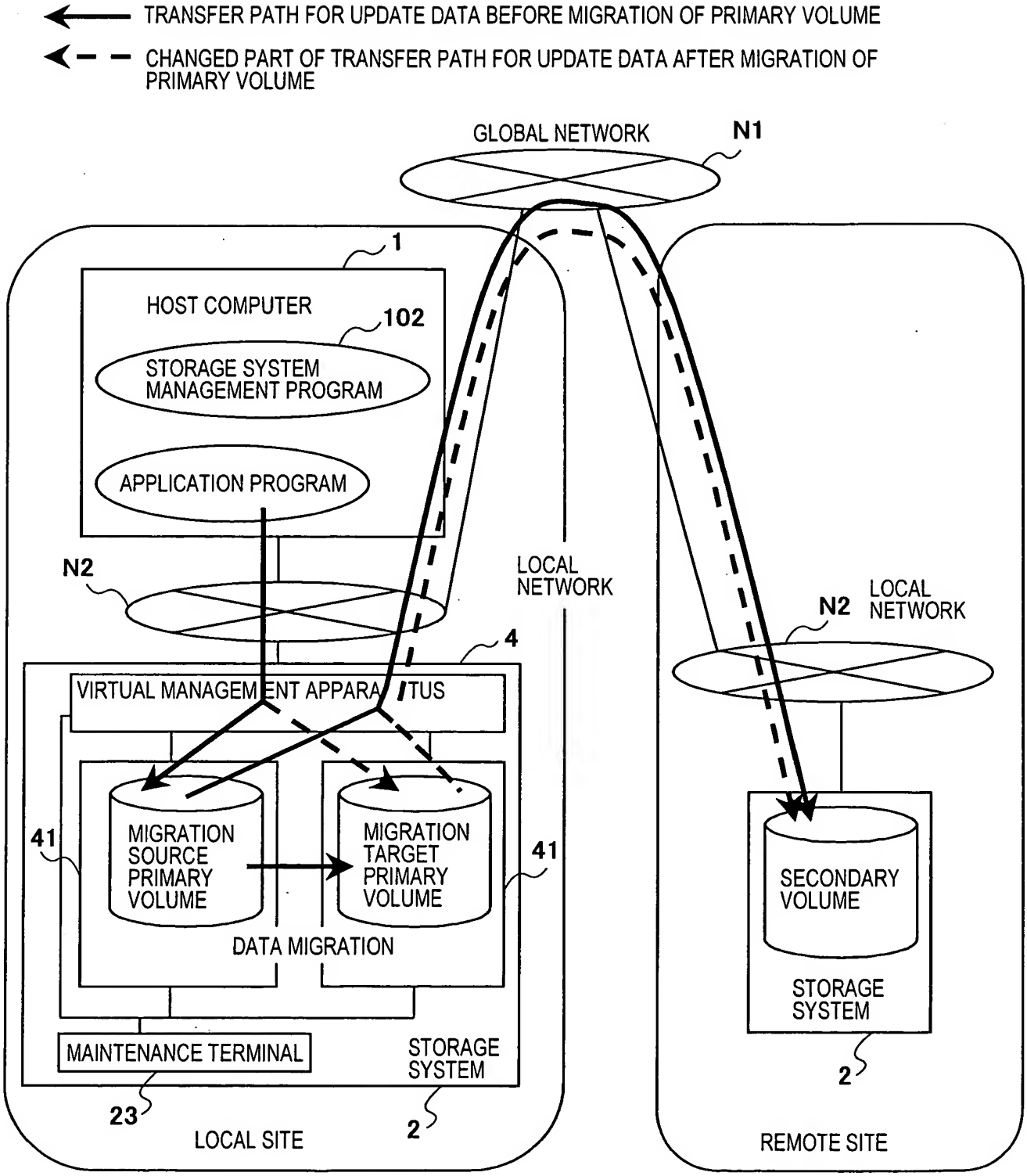

TRANSFER PATH FOR UPDATE DATA BEFORE MIGRATION OF PRIMARY VOLUME
CHANGED PART OF TRANSFER PATH FOR UPDATE DATA AFTER MIGRATION OF PRIMARY VOLUME
GLOBAL NETWORK
N1
1
HOST COMPUTER
102
STORAGE SYSTEM MANAGEMENT PROGRAM
APPLICATION PROGRAM
N2
LOCAL NETWORK
N2
LOCAL NETWORK
4
VIRTUAL MANAGEMENT APPARATUS
41
MIGRATION SOURCE PRIMARY VOLUME
MIGRATION TARGET PRIMARY VOLUME
41
DATA MIGRATION
SECONDARY VOLUME
STORAGE SYSTEM
2
MAINTENANCE TERMINAL
STORAGE SYSTEM
23
2
LOCAL SITE
REMOTE SITE

FIG.20

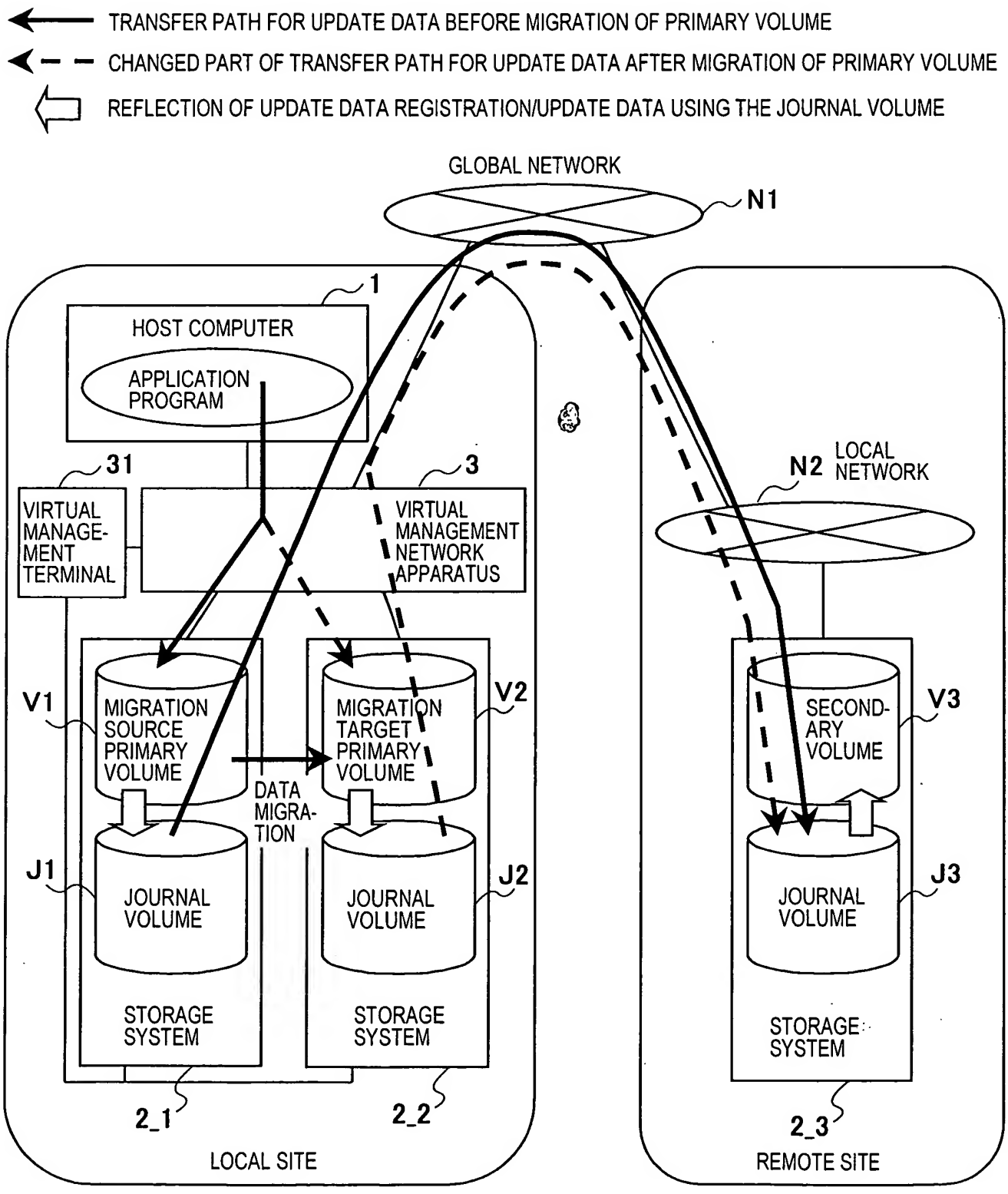

TRANSFER PATH FOR UPDATE DATA BEFORE MIGRATION OF PRIMARY VOLUME
CHANGED PART OF TRANSFER PATH FOR UPDATE DATA AFTER MIGRATION OF PRIMARY VOLUME
REFLECTION OF UPDATE DATA REGISTRATION/UPDATE DATA USING THE JOURNAL VOLUME
GLOBAL NETWORK
N1
1
HOST COMPUTER
APPLICATION PROGRAM
31
3
VIRTUAL MANAGE-MENT TERMINAL
VIRTUAL MANAGEMENT NETWORK APPARATUS
N2
LOCAL NETWORK
V1
MIGRATION SOURCE PRIMARY VOLUME
V2
MIGRATION TARGET PRIMARY VOLUME
DATA MIGRA-TION
V3
SECOND-ARY VOLUME
J1
JOURNAL VOLUME
J2
JOURNAL VOLUME
J3
JOURNAL VOLUME
STORAGE SYSTEM
STORAGE SYSTEM
STORAGE SYSTEM
2_1
2_2
2_3
LOCAL SITE
REMOTE SITE

FIG.21

SEQUENCE NUMBER	VOLUME UPDATE INFORMATION			DATA AREA ADDRESS
	VOLUME NUMBER	ADDRESS	DATA LENGTH	
⋮	⋮	⋮	⋮	⋮
8245	4	1020	4	5120
8246	6	1520	16	5124
⋮	⋮	⋮	⋮	⋮
8261	5	2021	8	5233

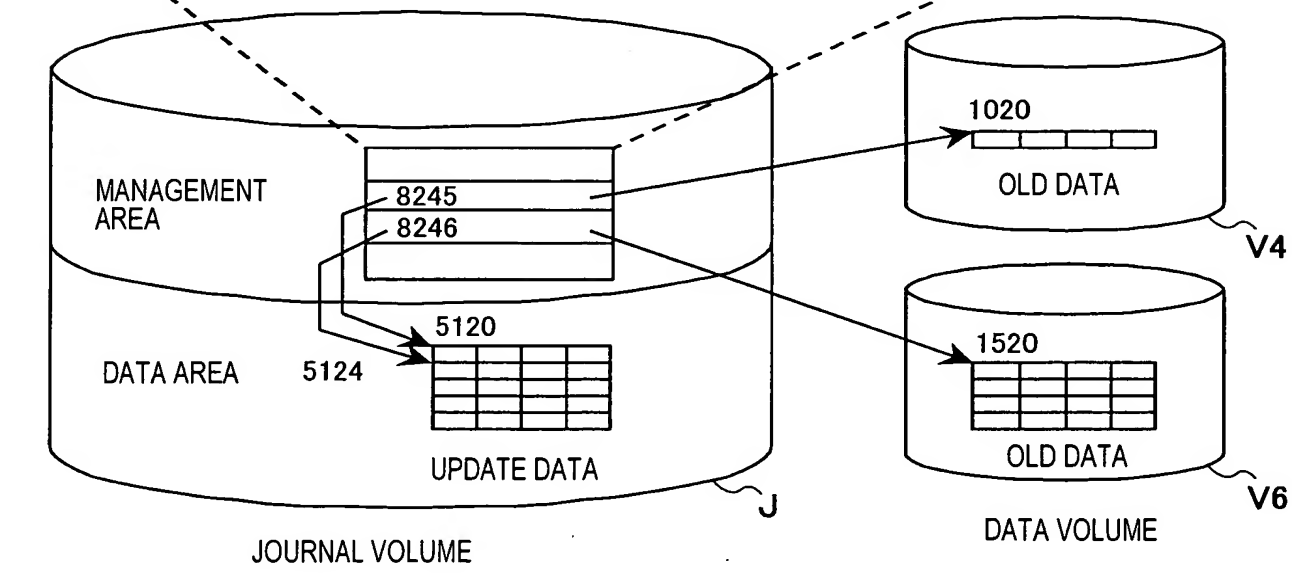


FIG.22A

SEQUENCE NUMBER COUNTER			8262
EMPTY JOURNAL MANAGEMENT INFORMATION	AVAILABLE TOP ADDRESS	MANAGEMENT AREA	2762
		DATA AREA	5241
	AVAILABLE END ADDRESS	MANAGEMENT AREA	2625
		DATA AREA	4860
JOURNAL-IN-USE MANAGEMENT INFORMATION	STORED	SEQUENCE NUMBER	8261
		MANAGEMENT AREA ADDRESS	2761
	TRANSFERRED	SEQUENCE NUMBER	8187
		MANAGEMENT AREA ADDRESS	2687
	APPLIED	SEQUENCE NUMBER	8135
		MANAGEMENT AREA ADDRESS	2635
	DISCARDED	SEQUENCE NUMBER	8125
		MANAGEMENT AREA ADDRESS	2625

FIG.22B

VOLUME LIST	VOLUME 1	VOLUME NUMBER	8
		NUMBER OF MANAGEMENT AREAS	400
		NUMBER OF DATA AREAS	800
	VOLUME 2	VOLUME NUMBER	9
		NUMBER OF MANAGEMENT AREAS	600
		NUMBER OF DATA AREAS	1200
	⋮	⋮	⋮
	VOLUME H	VOLUME NUMBER	12
		NUMBER OF MANAGEMENT AREAS	1000
		NUMBER OF DATA AREAS	2000
MANAGEMENT AREA ADDRESS TABLE	0	VOLUME NUMBER	8
		ADDRESS	0
	400	VOLUME NUMBER	9
		ADDRESS	0
	⋮	⋮	⋮
DATA AREA ADDRESS TABLE	0	VOLUME NUMBER	8
		ADDRESS	400
	800	VOLUME NUMBER	9
		ADDRESS	600
	⋮	⋮	⋮

FIG.23

REMOTE COPY OBJECT FLAG	OFF/COPY SOURCE/COPY TARGET
JOURNAL VOLUME FLAG	ON(OFF)
JOURNAL MANAGEMENT INFORMATION NUMBER	1 ～ N
NEWEST SEQUENCE NUMBER	M
PAIR STATE	COPYING/DUPLICATED/SUSPENDING
DIFFERENTIVAL BIT MAP	010010 ▪ ▪ ▪
COPY SOURCE INFORMATION	COPY SOURCE 1 ADDRESS INFORMATION
	COPY SOURCE 2 ADDRESS INFORMATION
COPY SOURCE VALID FLAG	1/2/TRANSITIONAL
COPY TARGET INFORMATION	COPY TARGET ADDRESS INFORMATION
READ/WRITE MODE	NORMAL/THROUGH/ PENDING/DATA MIGRATING
DATA MIGRATION SOURCE INFORMATION	DATA MIGRATION SOURCE ADDRESS INFORMATION
DATA MIGRATION TARGET INFORMATION	DATA MIGRATION TARGET ADDRESS INFORMATION
DATA MIGRATION COMPLETION BIT MAP	010010 ▪ ▪ ▪

FIG.24

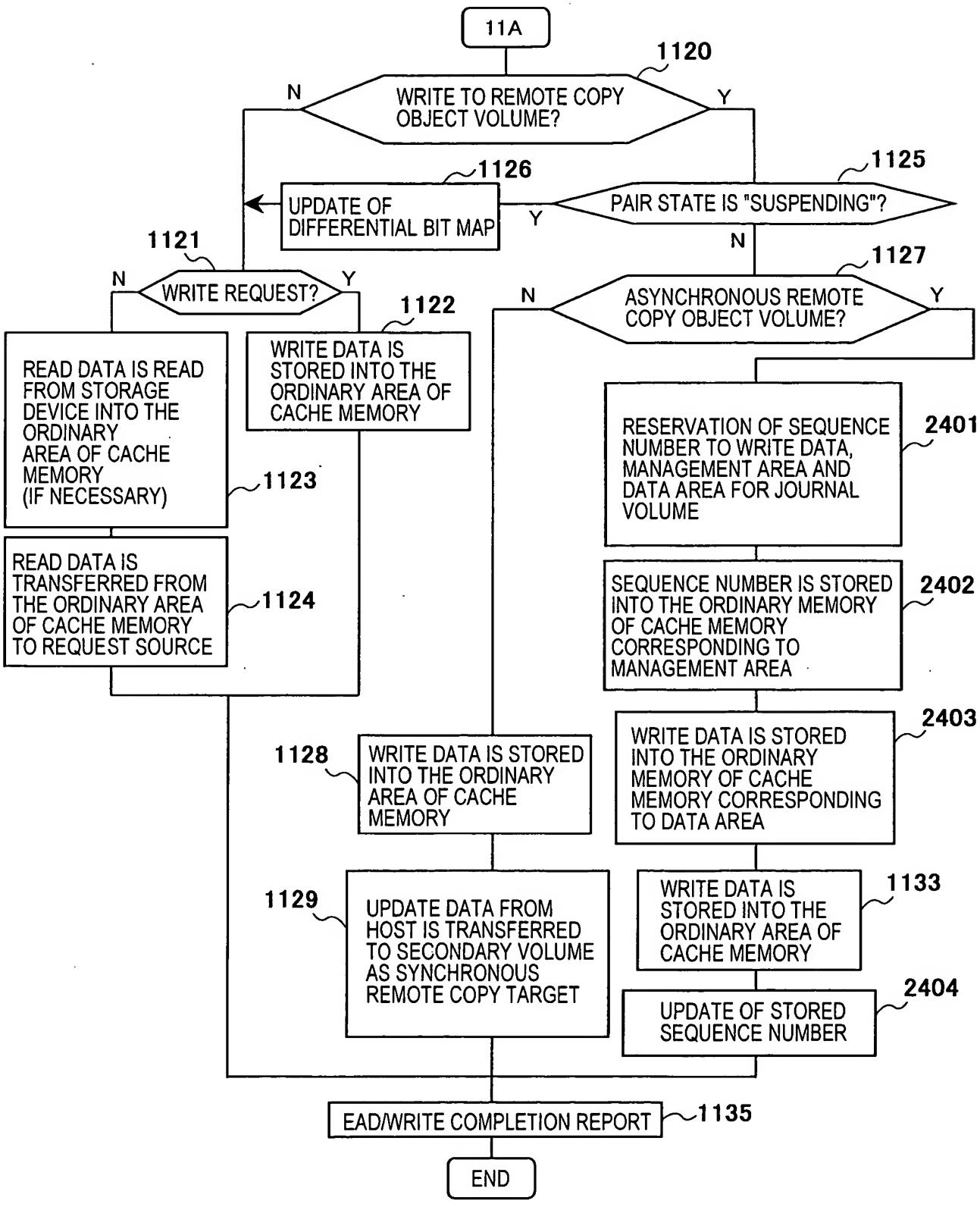

11A
1120
WRITE TO REMOTE COPY OBJECT VOLUME?
N
Y
1126
UPDATE OF DIFFERENTIAL BIT MAP
1125
PAIR STATE IS "SUSPENDING"?
Y
N
1121
WRITE REQUEST?
N
Y
1127
ASYNCHRONOUS REMOTE COPY OBJECT VOLUME?
N
Y
1122
WRITE DATA IS STORED INTO THE ORDINARY AREA OF CACHE MEMORY
READ DATA IS READ FROM STORAGE DEVICE INTO THE ORDINARY AREA OF CACHE MEMORY (IF NECESSARY)
1123
READ DATA IS TRANSFERRED FROM THE ORDINARY AREA OF CACHE MEMORY TO REQUEST SOURCE
1124
RESERVATION OF SEQUENCE NUMBER TO WRITE DATA, MANAGEMENT AREA AND DATA AREA FOR JOURNAL VOLUME
2401
SEQUENCE NUMBER IS STORED INTO THE ORDINARY MEMORY OF CACHE MEMORY CORRESPONDING TO MANAGEMENT AREA
2402
WRITE DATA IS STORED INTO THE ORDINARY MEMORY OF CACHE MEMORY CORRESPONDING TO DATA AREA
2403
1128
WRITE DATA IS STORED INTO THE ORDINARY AREA OF CACHE MEMORY
1129
UPDATE DATA FROM HOST IS TRANSFERRED TO SECONDARY VOLUME AS SYNCHRONOUS REMOTE COPY TARGET
WRITE DATA IS STORED INTO THE ORDINARY AREA OF CACHE MEMORY
1133
UPDATE OF STORED SEQUENCE NUMBER
2404
EAD/WRITE COMPLETION REPORT
1135
END

FIG.25

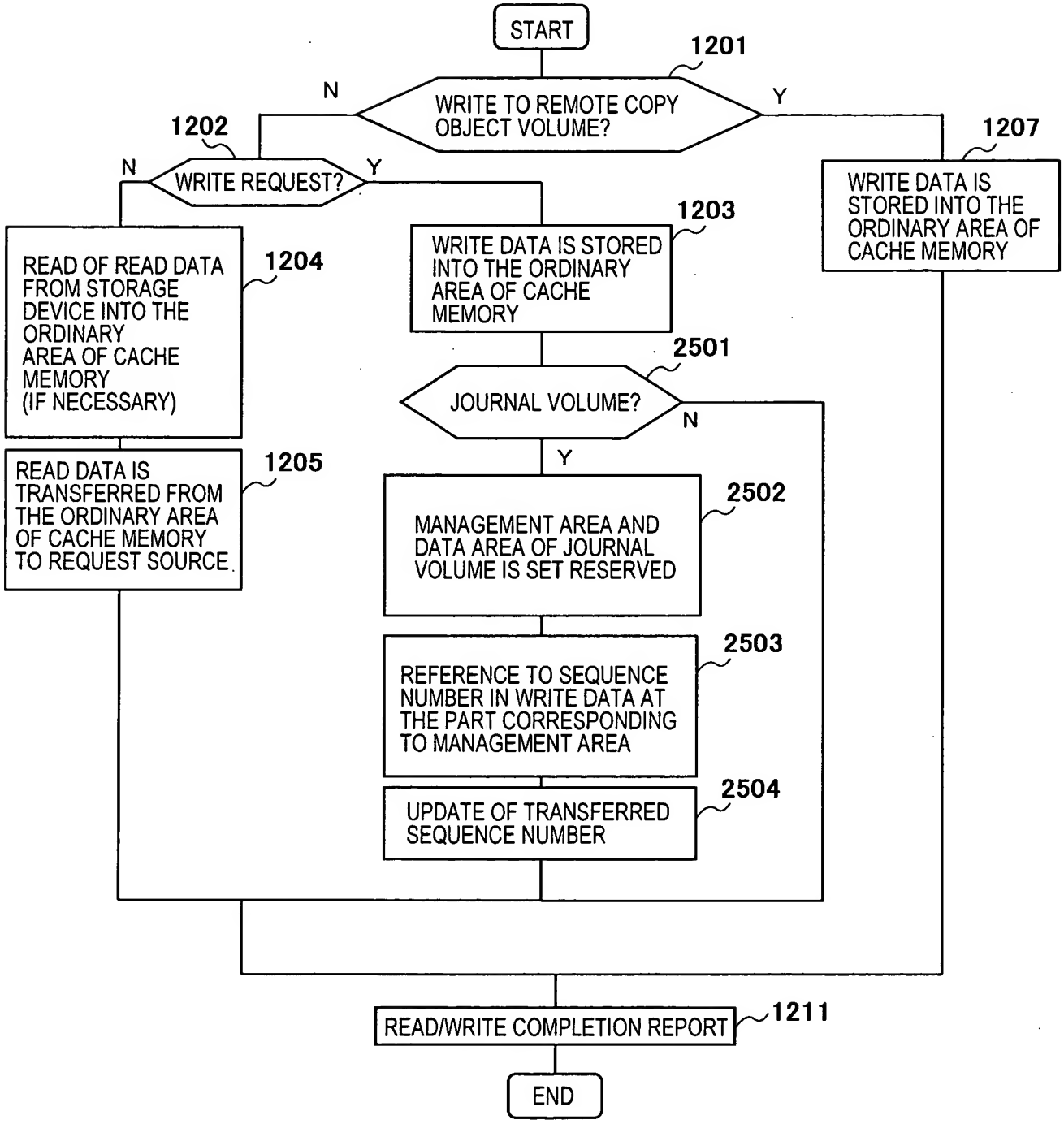

START
1201
WRITE TO REMOTE COPY OBJECT VOLUME?
N
Y
1202
WRITE REQUEST?
N
Y
1207
WRITE DATA IS STORED INTO THE ORDINARY AREA OF CACHE MEMORY
1203
WRITE DATA IS STORED INTO THE ORDINARY AREA OF CACHE MEMORY
1204
READ OF READ DATA FROM STORAGE DEVICE INTO THE ORDINARY AREA OF CACHE MEMORY (IF NECESSARY)
2501
JOURNAL VOLUME?
N
Y
1205
READ DATA IS TRANSFERRED FROM THE ORDINARY AREA OF CACHE MEMORY TO REQUEST SOURCE
2502
MANAGEMENT AREA AND DATA AREA OF JOURNAL VOLUME IS SET RESERVED
2503
REFERENCE TO SEQUENCE NUMBER IN WRITE DATA AT THE PART CORRESPONDING TO MANAGEMENT AREA
2504
UPDATE OF TRANSFERRED SEQUENCE NUMBER
1211
READ/WRITE COMPLETION REPORT
END

FIG.26

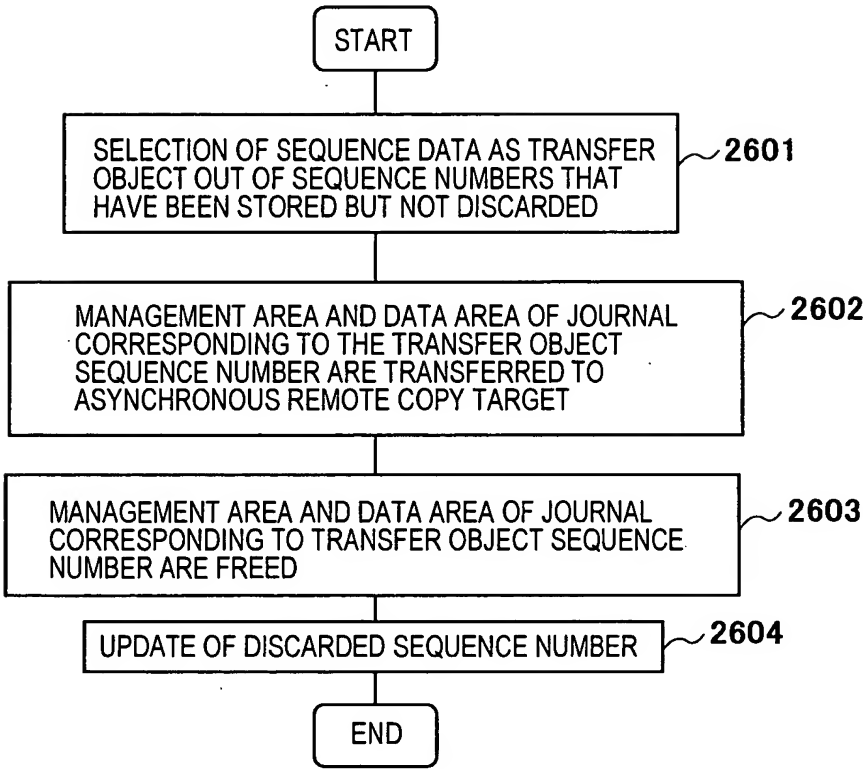

START
SELECTION OF SEQUENCE DATA AS TRANSFER OBJECT OUT OF SEQUENCE NUMBERS THAT HAVE BEEN STORED BUT NOT DISCARDED
2601
MANAGEMENT AREA AND DATA AREA OF JOURNAL CORRESPONDING TO THE TRANSFER OBJECT SEQUENCE NUMBER ARE TRANSFERRED TO ASYNCHRONOUS REMOTE COPY TARGET
2602
MANAGEMENT AREA AND DATA AREA OF JOURNAL CORRESPONDING TO TRANSFER OBJECT SEQUENCE NUMBER ARE FREED
2603
UPDATE OF DISCARDED SEQUENCE NUMBER
2604
END

FIG.27

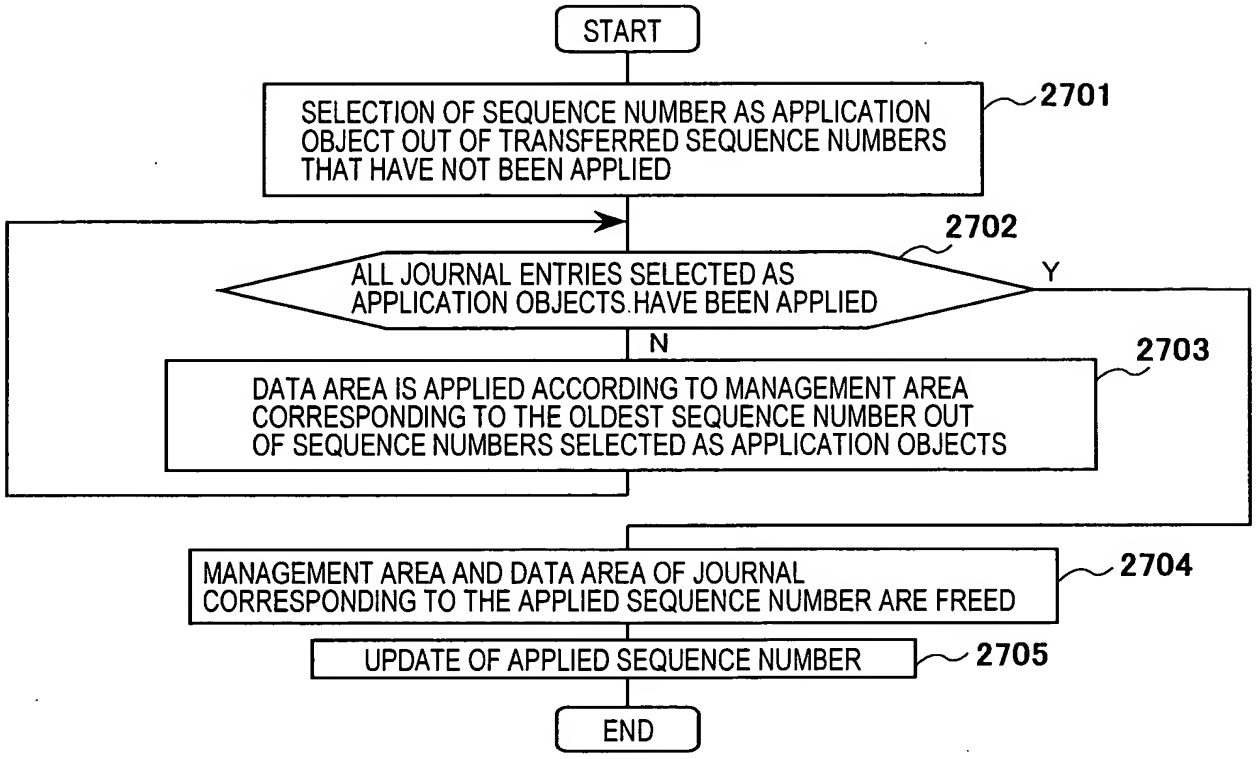

START
SELECTION OF SEQUENCE NUMBER AS APPLICATION OBJECT OUT OF TRANSFERRED SEQUENCE NUMBERS THAT HAVE NOT BEEN APPLIED
2701
2702
ALL JOURNAL ENTRIES SELECTED AS APPLICATION OBJECTS HAVE BEEN APPLIED
Y
N
2703
DATA AREA IS APPLIED ACCORDING TO MANAGEMENT AREA CORRESPONDING TO THE OLDEST SEQUENCE NUMBER OUT OF SEQUENCE NUMBERS SELECTED AS APPLICATION OBJECTS
MANAGEMENT AREA AND DATA AREA OF JOURNAL CORRESPONDING TO THE APPLIED SEQUENCE NUMBER ARE FREED
2704
UPDATE OF APPLIED SEQUENCE NUMBER
2705
END

FIG.28

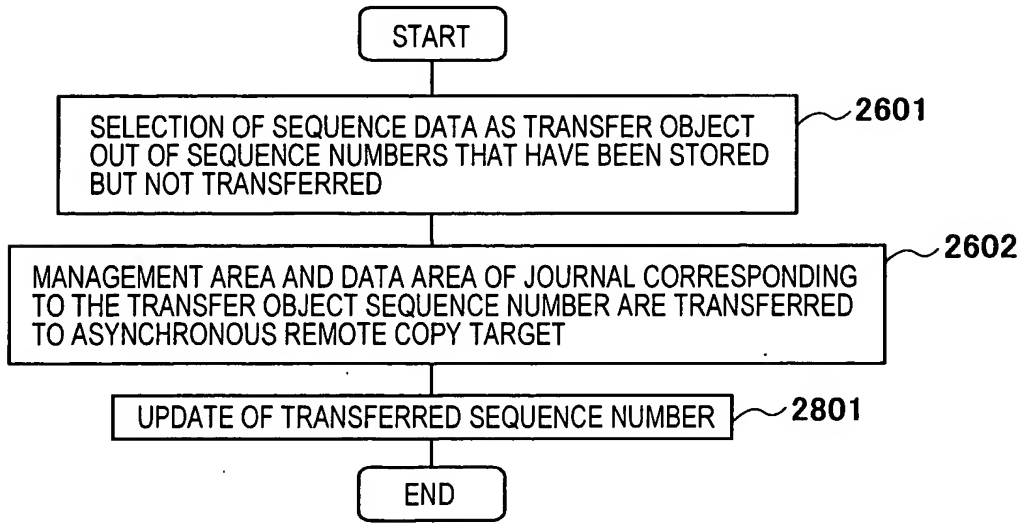

START
SELECTION OF SEQUENCE DATA AS TRANSFER OBJECT OUT OF SEQUENCE NUMBERS THAT HAVE BEEN STORED BUT NOT TRANSFERRED
2601
MANAGEMENT AREA AND DATA AREA OF JOURNAL CORRESPONDING TO THE TRANSFER OBJECT SEQUENCE NUMBER ARE TRANSFERRED TO ASYNCHRONOUS REMOTE COPY TARGET
2602
UPDATE OF TRANSFERRED SEQUENCE NUMBER
2801
END

FIG.29

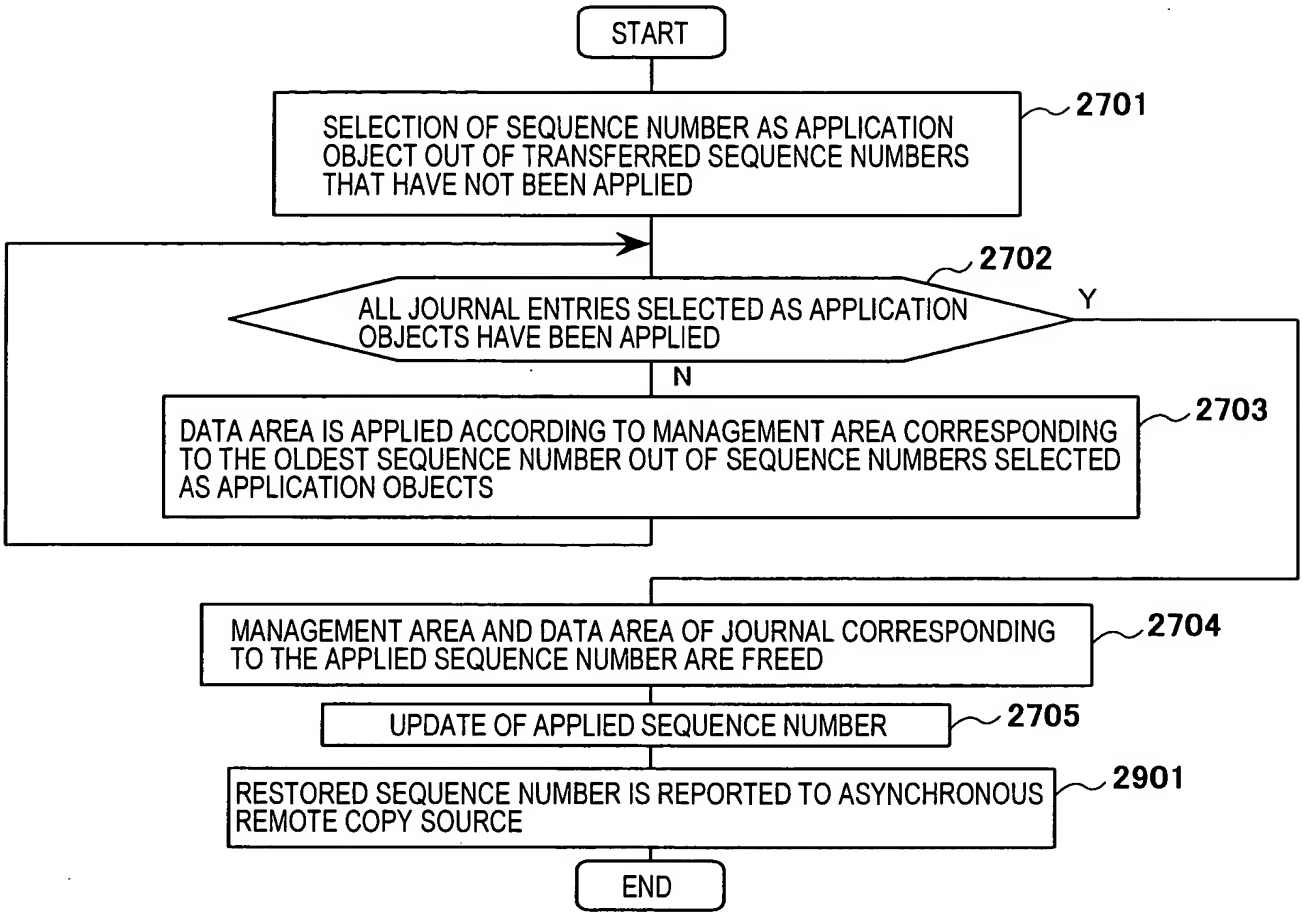

START
SELECTION OF SEQUENCE NUMBER AS APPLICATION OBJECT OUT OF TRANSFERRED SEQUENCE NUMBERS THAT HAVE NOT BEEN APPLIED
2701
2702
ALL JOURNAL ENTRIES SELECTED AS APPLICATION OBJECTS HAVE BEEN APPLIED
Y
N
DATA AREA IS APPLIED ACCORDING TO MANAGEMENT AREA CORRESPONDING TO THE OLDEST SEQUENCE NUMBER OUT OF SEQUENCE NUMBERS SELECTED AS APPLICATION OBJECTS
2703
MANAGEMENT AREA AND DATA AREA OF JOURNAL CORRESPONDING TO THE APPLIED SEQUENCE NUMBER ARE FREED
2704
UPDATE OF APPLIED SEQUENCE NUMBER
2705
RESTORED SEQUENCE NUMBER IS REPORTED TO ASYNCHRONOUS REMOTE COPY SOURCE
2901
END

FIG.30

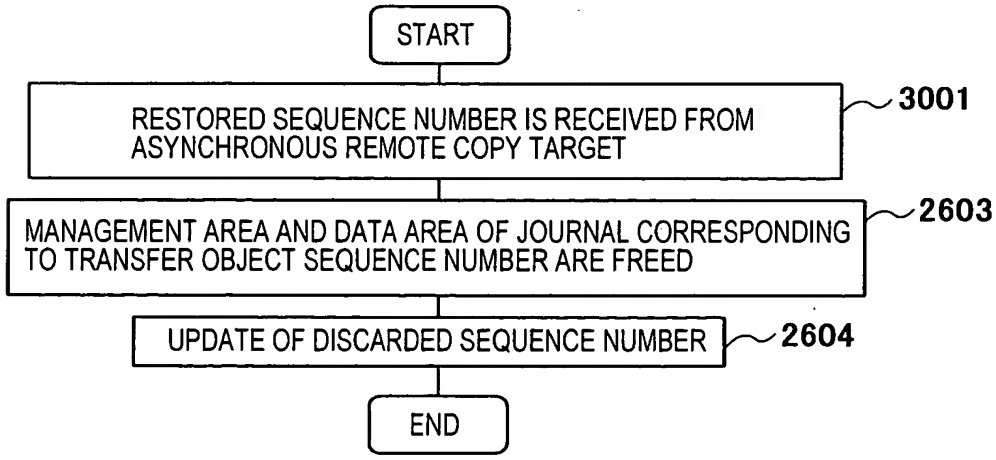

START
RESTORED SEQUENCE NUMBER IS RECEIVED FROM ASYNCHRONOUS REMOTE COPY TARGET
3001
MANAGEMENT AREA AND DATA AREA OF JOURNAL CORRESPONDING TO TRANSFER OBJECT SEQUENCE NUMBER ARE FREED
2603
UPDATE OF DISCARDED SEQUENCE NUMBER
2604
END

FIG.31

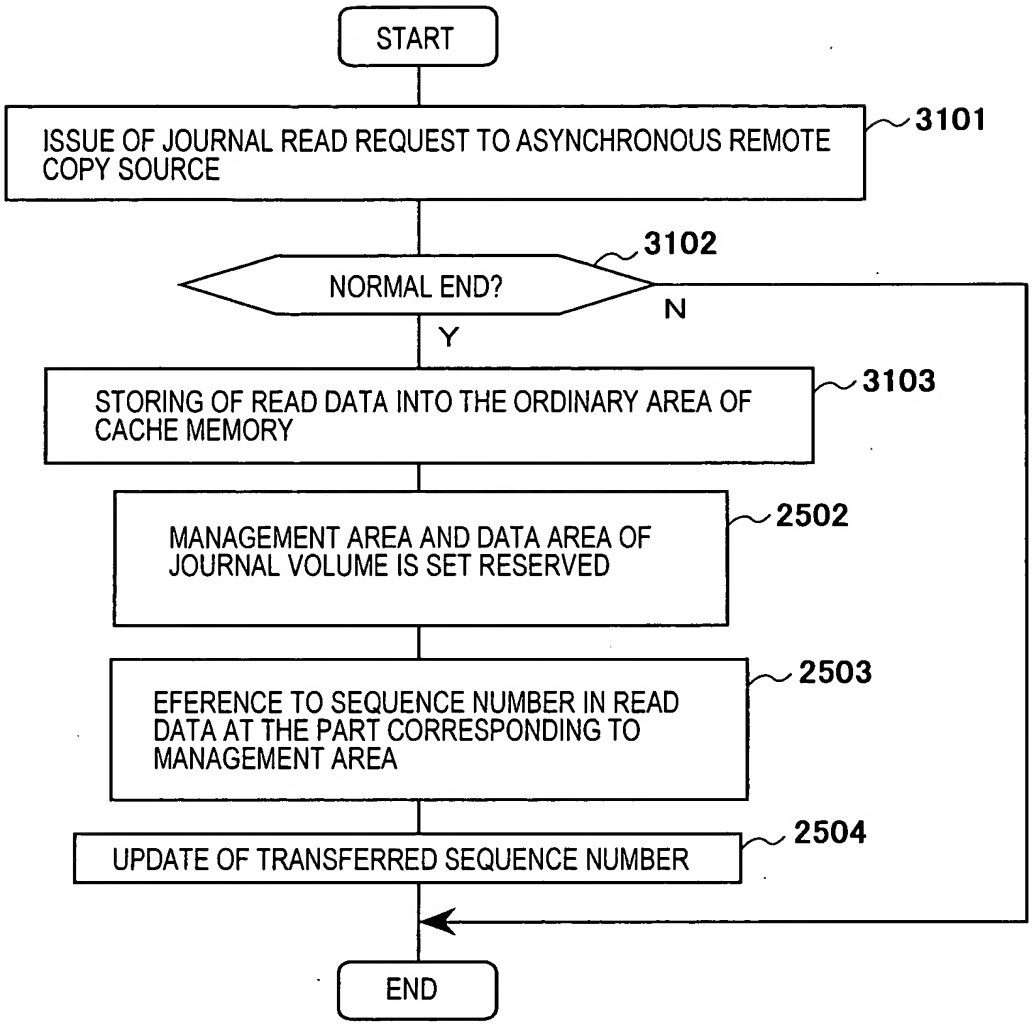
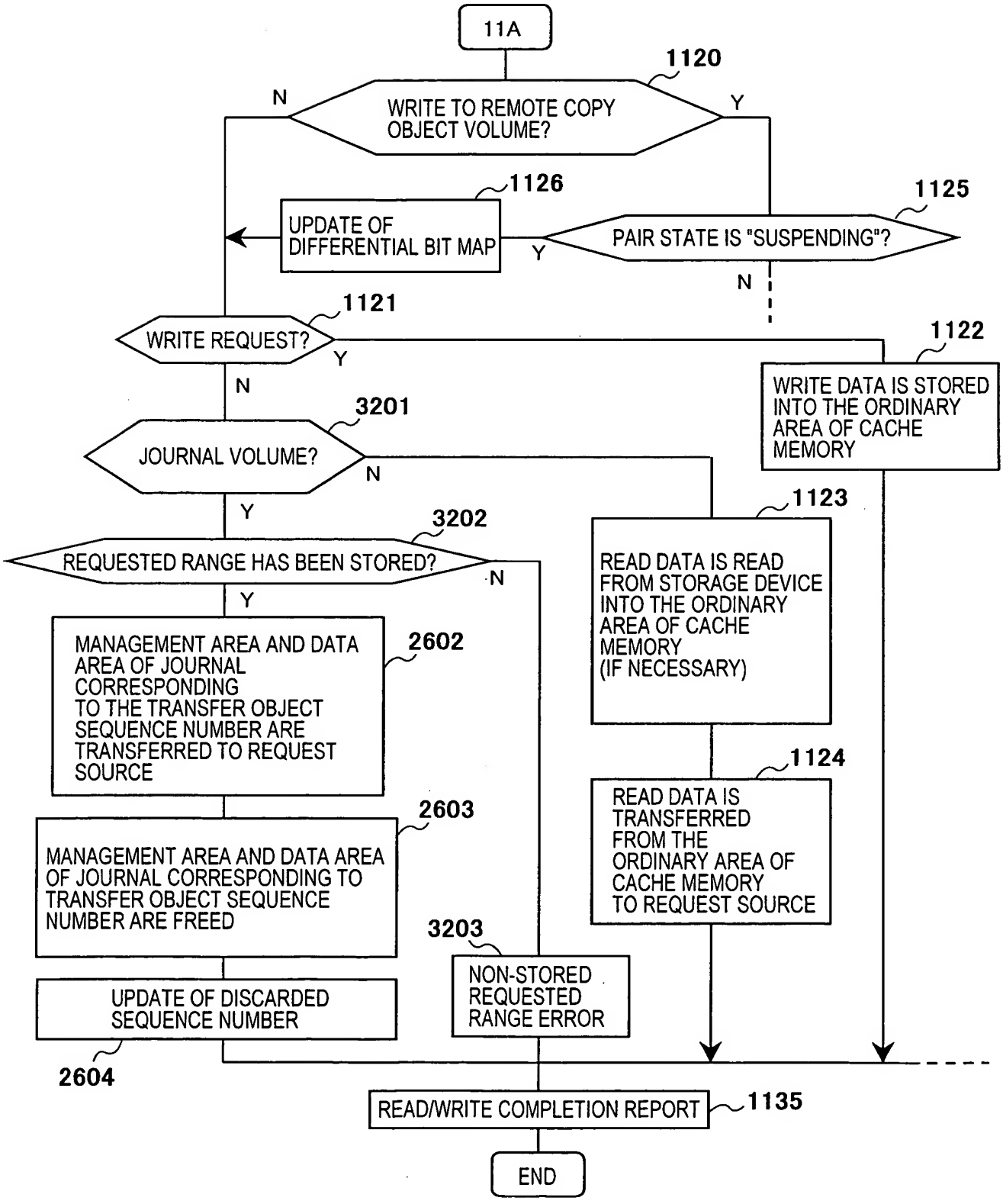

START
ISSUE OF JOURNAL READ REQUEST TO ASYNCHRONOUS REMOTE COPY SOURCE
3101
3102
NORMAL END?
N
Y
STORING OF READ DATA INTO THE ORDINARY AREA OF CACHE MEMORY
3103
MANAGEMENT AREA AND DATA AREA OF JOURNAL VOLUME IS SET RESERVED
2502
EFERENCE TO SEQUENCE NUMBER IN READ DATA AT THE PART CORRESPONDING TO MANAGEMENT AREA
2503
UPDATE OF TRANSFERRED SEQUENCE NUMBER
2504
END

FIG.32


11A
1120
WRITE TO REMOTE COPY OBJECT VOLUME?
N
Y
1126
UPDATE OF DIFFERENTIAL BIT MAP
1125
PAIR STATE IS "SUSPENDING"?
Y
N
1121
WRITE REQUEST?
Y
1122
WRITE DATA IS STORED INTO THE ORDINARY AREA OF CACHE MEMORY
N
3201
JOURNAL VOLUME?
N
Y
3202
REQUESTED RANGE HAS BEEN STORED?
N
Y
1123
READ DATA IS READ FROM STORAGE DEVICE INTO THE ORDINARY AREA OF CACHE MEMORY (IF NECESSARY)
MANAGEMENT AREA AND DATA AREA OF JOURNAL CORRESPONDING TO THE TRANSFER OBJECT SEQUENCE NUMBER ARE TRANSFERRED TO REQUEST SOURCE
2602
1124
READ DATA IS TRANSFERRED FROM THE ORDINARY AREA OF CACHE MEMORY TO REQUEST SOURCE
2603
MANAGEMENT AREA AND DATA AREA OF JOURNAL CORRESPONDING TO TRANSFER OBJECT SEQUENCE NUMBER ARE FREED
3203
NON-STORED REQUESTED RANGE ERROR
UPDATE OF DISCARDED SEQUENCE NUMBER
2604
READ/WRITE COMPLETION REPORT
1135
END